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THE

ELECTRICIAN;

A WEEKLY JOURNAL

OF

TELEGRAPHY, ELECTRICITY, AND APPLIED CHEMISTRY.

VOLUME I.

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TO OUR READERS.

We have the pleasure to announce the completion of the first Half-Yearly Volume of our Journal. In so doing, we may be allowed a few observations upon our aims, our prospects, and other matters concerning ourselves. Very many of our readers have taken a lively interest in the success of the new periodical, and in some cases have materially helped us in a task which has offered but little inducement save what a love of the science could give. To them, in the first place, are due our most kindly acknowledgments. In addressing them, and the general body of our readers, our feeling is different from that we should experience in regard to a class bound together by no kindred tastes and pursuits. "We are all labourers in the same field," and one of our highest interests is identical. With such a motive for friendly feeling, we may well think we are addressing friends. Thus, we will tell them that we count upon their continued support and interest to enable us to continue what we have begun, and to fulfil our task more and more satisfactorily—"*Vires acquirentes eundo!*"

There are one or two points upon which we desire to have an understanding. Writing upon science, which has its basis in truth, and not upon opinion, prejudice, or self-interest, we do not acknowledge the principle, propounded perhaps by some editorial Machiavelli, that "Editors should never make a mistake," and that "if they should fall into error they should never acknowledge it." We by no means pretend to be infallible. In an eager pursuit of truth we continually run the risk of falling, in some degree, into error. One of the first qualifications for science is a continual reservation of the possibility of misconception in regard to the conclusions we arrive at. Those who would affirm that all error is to be avoided by due care to advance nothing but what is certain, can in our opinion have but little acquaintance with the history of the progress of science. The most truthful conceptions have often been more or less blended with error; and in the twilight of a new science we may sometimes be mistaken, for all our tiny tapers, in peering into the mystery around us. Should we therefore, influenced by an *amour propre* which dreads the imputation of error, to which those who uncompromisingly attack it are most liable, renounce the great privilege which may be granted to our endeavours—of dispelling the darkness between us, and our wondrous dwelling-place, and the lights scattered in the infinitude around us? It may be necessary that we should speak with confidence where our confidence seems fully to be warranted; but we speak always under deference to higher authority—not the authority that merely a name may confer, nor any which is looked up to by the vulgar, but the authority of those who may have been enabled more successfully than we have, to learn and to interpret Nature's secrets. We therefore invite all friendly criticism, and the discussion in our own columns of the views we express.

We hold that it is more generally useful to disseminate and popularize science, and to extend our individual knowledge laterally, so to speak, than to build upwards upon what may be an inadequate foundation, and thus to reach a misty elevation, from which we must soon descend to widen our scope of observation. Moreover, those who love to enter into the hidden meaning of things, to trace their position as links in the chain of cause and effect, and who consequently may lay claim to the title of philosophers, are comparatively few; and, to fill our sphere of usefulness, we must also address those who possess what is known as a practical turn of mind, and who are mainly anxious to apply the materials furnished by scientific research. But we would avoid in any case giving the casket without the key, a mere detailed process without the knowledge which may render it really useful and applicable. Such "practical recipes" would be like the instructions commonly given with an electrotype apparatus—perfectly useless until the conditions upon which the action depends are more or less understood. We endeavour to avoid, on the one hand, the charge of being too exclusively theoretical; and on the other, the imputation of being superficial.

It will be perceived from the letter in our last week's impression, of an able and valuable contributor to our columns, who is endeavouring, by extending the application of the principles established by Ohm, to evoke order out of the confusion of the old electrical theories, that there is now, in actual competition with the latter, a new theory, very definite in all its parts, which we have for some weeks been gradually developing. We hail the commencement of a controversy which has now been fairly started, being convinced that this must prove beneficial to the elucidation of

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truth; and we look forward to the ultimate result with a confidence at least equal to that which may be experienced by those who still adhere to the views which hitherto have been more or less accepted, with such modifications as they have been found susceptible of. We think that this confidence is fully justified by what we have already advanced, and what we have further in preparation for publication. The subject is one of immense importance, and, as we have already implied, our pages are freely open to its discussion. Soliciting as we do such discussion, so far as our own opinions are implicated, we are not disposed to forbid it, within reasonable limits, in the case of any of our contributors, lest we might be found tolerating the promulgation of error without a possibility of that wholesome check which nothing but a "free ventilation" can confer. It should be remembered that in argument no position should be attacked until it has been fully stated, and is fully understood; but, when any one link in a chain of reasoning has been completed, it may fairly be tested by objection. Were it not so, such objection might often be indefinitely postponed and ultimately lost sight of, to the detriment both of the intelligent learner, and of those whose object is to verify their views and to establish their conclusions. It must be allowed, however, that in some cases the reader cannot reasonably expect that his objections should receive immediate answer. It is sufficient for all purposes that they should not be lost sight of.

We have the satisfaction of knowing that already we are well supported in the conclusions we have advanced in our "Steps to Theory," by many of the disciples of the ancient doctrines, who have felt that there was yet something wanting to make electricity an exact science, and to render it susceptible of vast extension in its bearings upon chemistry and other kindred sciences, and who believe that this something has now been found. Indeed, we imagine that few can be quite satisfied with a system which has not yet settled whether there be two electricities or only one, much less the laws and nature of electrical force. Nature does not so belong to us that we should seek to reduce any of her phenomena to an arbitrary system, which bears internal evidence that it is not that which prevailed when order and sequence were established in the universe. For our own part, in point of theory, we seek not to contrive or invent, but to discover—being convinced that useful invention is best realised in the application of the theory most in accordance with nature's laws.

Within the last six months many important events have happened bearing upon the progress of submarine telegraphy. The realization of an Atlantic telegraph, working under the most favourable conditions in regard to speed and permanent safety, is now looked forward to with confidence, as an enterprise offering more than ordinary chances of success, and which cannot long be deferred, by those—"*quorum pars magnaeramus*," who have latterly endeavoured to forward this great project, and to secure to this country the honour and benefits which should accrue from it. There is little doubt that the route of the old cable will again be adopted in this new venture. Nevertheless, in regard to this matter, a question of immense practical moment has arisen upon a point of theory. It has been asserted, upon eminent authority, that the difficulty due to inductive retardation, in working submarine cables, increases as the square of their lengths, a similar construction being supposed in every case. This conclusion, modified considerably by various other considerations, has been very generally accepted. Taken in conjunction with every modifying circumstance, it would distinctly imply that a line laid in several sections would possess considerable advantages in regard to rapidity of transmission over a line laid in one unbroken length. The North Atlantic route—from Scotland *via* the Faroe Isles, Iceland, and Greenland, to Labrador, would therefore, in spite of several obvious disadvantages in other respects, offer considerable inducements to carry a line through foreign possessions. It may be admitted that the use of relays between the sections of cable would be practically inexpedient or impossible; but the fact holds good, that by a possible combination of human agencies taking the place of the relays, signals might be transmitted by the northern route with greater expedition than by that which traverses the Atlantic *plateau*. It happens, however, that the conclusion to which we have referred, not only remains unverified by practice, but is opposed both to direct experiment, and to theoretical *data* free from all obscurity or complication. We hold it to be beyond doubt that, with the proper description of instruments available for our use, the difficulty in working submarine lines of telegraph increases very nearly in the simple ratio of their lengths. The evidence on this point appears to us conclusive in regard to the question of the choice of a route for the new Atlantic cable.

We may further state that we shall shortly have occasion to apply several new views in the elucidation of various problems of electro-telegraphy; and we will conclude our observations with the dictum of an old authority—now far more applicable than when first expressed:—that "The study of electricity possesses much that is admirably adapted to discipline the mind."

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The Electrician.

Vol. I. No. 1.—November 9, 1861.

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INTRODUCTORY.

A Publication specially devoted to the interests of Electro-Telegraphy, and to the advancement and application of those branches of Science upon which it is founded, has long been a desideratum in this country and its Colonies. The professions of the Engineer, Mechanical Science, Railways, Photogaphy, and Technical Chemistry, are fully represented by their own organs in English journalism; and abroad, Telegraphy and Electricity have many publications to forward their progress. The growing importance of the applications of Electricity, and the vast interests involved in them, appear to render the establishment of the present journal almost a necessity. Those who earnestly follow one broad pursuit based upon scientific principles, may derive many advantages from a medium of communication and information specially intended to promote their particular branch of inquiry To the somewhat tardy interference and supervision of the scientific press, Telegraphy has lately been indebted for the exposure of many abuses, and shortcomings to which is mainly to be traced the loss of confidence, on the part of the public, in undertakings which are among the most important of the present day, and which, at the onset, were met with almost universal enthusiasm. But this wholesome publicity, through which the position of Telegraphy has been materially improved, might have been more effectually and promptly secured had a journal been in existence whose province of inquiry had particular reference to Telegraphic matters. The various "depressing influences" which have in many instances rendered success in Telegraphic enterprises almost an impossibility, and which, until lately, have been adverse to all improvement, are best to be combated by publicity, discussion, and the free interchange of ideas among Electricians and Telegraph Engineers. Thus, in nine cases out of ten, an honest and rational opinion, or a solid improvement, may make headway against apathy or self-interest, and find acceptance in theory and practice.

While enabling the Telegraphist to keep *au courant* with the scientific and material progress of his profession, "The Electrician" is designed to meet the requirements of the student in a field of knowledge which is every day being extended, and which, in all probability, is destined to solve many of the most important problems connected with the well-being of mankind. Every contribution to Electrical Science, and every important application of Chemistry taking place in this country, will, as far as possible, be made known and rendered available through the medium of our columns; which moreover, will form a record of the progress in these twin sciences which may be effected abroad. Any unnecessary amount of technicality or abstruseness will be avoided, so as to render useful truths comprehensible to all who may employ them. Thus it is confidently expected that the present undertaking will meet with the support of a large body of those who are interested in scientific progress, and prove beneficial to the extension of sound practical knowledge.

Communications of great importance and interest, connected with Telegraphy, are now forwarded indicrisminately to a large number of periodicals and daily publications. The consequence is, that few of these articles are ever extensively read by the class for whom they are intended; and great trouble and inconvenience in searching for such communications must be experienced to those who wish to be acquainted with all that is published on the subject of Telegraphy. In the absence of any general medium for Telegraphic news, this search has to be extended to a variety of papers whose general scope of inquiry is altogether unconnected with the subject in question. It is to be observed, that Telegraphists as a body are generally most anxious to keep up their information on Telegraphic matters.

"The Electrician" will, therefore, supply a want that is greatly felt, and thus be received by Telegraphists as a welcome addition to Scientific Literature.

In regard to the arrangements which have been made to secure the adequate treatment of many subjects of importance which may fall within our province, it may be stated that several Gentlemen of the highest attainments in Electrical Science will be connected with this journal, as Scientific Referees upon various questions where their knowledge and experience may render their authority of peculiar value. Our object will be, however, to promote perfect freedom of discussion within reasonable bounds, and to find expression for every well-grounded opinion which may affect the progress of Telegraphy.

Great attention will be paid to Commercial affairs, and the several topics connected with this department will be discussed with conciseness and strict impartiality.

THE TELEGRAPH TO INDIA.

Sir Macdonald Stephenson is determined to earn, by a bold and well-calculated stroke of policy, the success and the credit he failed to share in the secondary position he occupied at the Board of the old Red Sea and India Telegraph Company. In following the initiative he has taken, an absolute and complete failure is almost an impossibility; and the horizon which may be opened out by a small share of success, is one which affords a brilliant prospect and many opportunities. We are anxious now and hereafter to give all honour to those who can appreciate with us the immense difference between the past and the present position of submarine telegraphy, and who have energy and decision to act upon their conviction on this point. A concession or a privilege, which formerly may have been of questionable value to telegraphic enterprise, will be of fifty-fold importance to those who have carefully followed the scientific and practical data which form the sum of our present experience. Here, then, is an opportunity which those who see and seize may hold when a new era in telegraphy has been registered in history and has become evidenced in human progress. Unfortunately, the facts which, in showing where our weakness lay, have made us conscious of our strength, are not of the class which receive the ready appreciation of the public. Knowledge, however valuable, must receive some application in practice before its importance can become fully recognized as an element of success in commercial undertakings. Thus, public confidence must be consequent, in some degree, upon that which is displayed by the originators of telegraphic projects. Anything, however,

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which at the present moment is broached in regard to telegraphic enterprise must be characterised rather by extreme prudence and moderation than by comprehensiveness; albeit, the successful laying of the Malta and Alexandria cable—*alias* the Rangoon cable, *née* Gibraltar—must be regarded as some encouragement to similar undertakings. *Nil nisi bonum* is all we hear respecting the electrical condition of this line; and we are, therefore, fain to conclude, that its original strength of constitution has enabled it to withstand the serious trials which, as we know, beset its infancy. But it is not on the method of construction adopted in this cable that our hopes for the future are exclusively based; nor had the comforting conclusions arrived at in the Government Report, any special reference to the improvement which was certainly in some degree visible in this undertaking. We believe, that to achieve the permanent success of undertakings in submarine telegraphy, principles must be applied which, more or less, have been neglected in all telegraphic enterprises up to the present date.

Our approval of the project instituted by Sir M. Stephenson must, therefore, be given, *cum grano salis*. We fully recognize the expediency of the undertaking, and the credit which is due to its promoters. We are willing to believe, that most of the sections of cable which form the Red Sea line are not wholly lost, and that, at a comparatively small expense, they may be placed in working order. We perceive, that if what is proposed is done, much more may be accomplished. But, that the line can ever be resuscitated and restored to perform its functions satisfactorily and permanently, is a view which is negatived by its originally faulty construction. A cable which cost £60,000 for repairs, and subsequently failed within five days, is not, in the abstract, a very encouraging object for the expenditure of further capital. Nevertheless, in the existing condition of things, when the question of a new and efficient line of cable assumes too startling an aspect to be brought before the public, the expenditure of £100,000, or more, upon an undertaking which already represents a capital of eight times that amount, and which is to be transferred "on very liberal terms," affords a prospect of proximate and ultimate success, which will doubtless be appreciated by the public, as it has been by the originators of the project. "The venture is small; while the returns will be (or may be) on the scale of an original expenditure of £800,000." The concession also, together with the cables, land lines, instruments, and stations, is to be made over to the new Company. Should the commercial aspect of submarine undertakings be modified by the improvements in practical electrical science, as we consider cannot fail to be the case, this concession will place the Company among the first of those who will profit by the extension of telegraphy.

The Company propose, in the first instance, to effect the restoration of the line between Aden and Kurrachee, by far the easiest portion of the work before them. Here there are three sections of cable: that from Aden to Hallani, a distance of 718 knots; from Hallani to Muskat, 486 knots; and from Muskat to Kurrachee, 481 knots. In the first section, a fault became evident about three months after the line was laid, which completely interrupted the working of the cable. It is supposed to be at a joint, 230 miles from Aden, and in comparatively shallow water. The second section is that which is referred to in the prospectus as being in good working order. The third section has failed at the Kurrachee shore end, and probably may be easily repaired. It is to be observed, that the cable from Hallani to Muskat lies in shallow water, and upon a bottom of mud or sand. This is by no means the case with other sections of the line, although, according to Mr. F. C. Webb, and other advocates of shallow water cables, the Red Sea line need not, and ought not, to have been treated as a deep-water telegraph. We presume that an exception must be made to this statement, in regard to the Muskat and Kurrachee section, in which 100 miles of cable lies in 1000 fathoms, the maximum depth being 1900 fathoms. The form of cable, however, adopted throughout the Red Sea line renders it unfit either for shallow or deep water. Its high specific gravity in proportion to its strength renders such a cable unsafe to lay in deep water, or to recover in moderate depths; while the faults which have occurred at the shore ends sufficiently show that its weight is altogether insufficient for shallow water.

The section of cable from Suez to Kosseir, the restoration of which will probably be undertaken subsequently to the above, presents but little difficulty, the fault existing in close proximity to Kosseir. That from Kosseir to Suakin, which was always faulty, has lately failed. The cable from Suakin to Aden is so faulty, that there can be but little hope of its restoration, even for a short period of time. The length of the latter section is 629 knots, that of the Suez to Kosseir section being 255, and of the Kosseir to Suakin section 474 knots. An important feature of the project before us is the establishment of land wires, on the coast of Arabia, should they be found necessary, to replace any section of cable.

It would, indeed, be contrary to the general spirit of the age, if the task of completing electrical communication with India, and of linking the Old World with the New, were left for any length of time unfulfilled. We therefore hail this project as the result of a healthy spirit of enterprise, which, though commencing upon a somewhat inadequate basis, may ultimately obtain a broad and important field of action.

ARTIFICIAL SUNLIGHT.

The production of a cheap and brilliant artificial light, before which, that of coal-gas, so great an acquisition in its time, will "pale its ineffectual fires," is certainly one of the most important practical problems of chemical and electrical science. It is a fact which is scarcely appreciated, that this problem is, and for some time has been, more than half solved in both sciences. We cannot in all cases say much as to comparative cheapness and present practicability; but we already possess the dazzling arc of light between graphite points, the no less brilliant mercury stream of Professor Way, and the vivid white lustre of lime heated by the combining constituents of water; each and all of which might be made applicable to our every day, or rather evening, existence. Sunlight,—carefully softened, subdued, and distributed, perhaps tinted with those colours which are most pleasing and least trying to the eye, what can be more beautiful? We have this at our command, and we know that it is accompanied with advantages in regard to health and comfort, possessed by no other means of illumination;—shall we fail to apply it? Are we still to breathe the heated and unwholesome atmosphere of the theatre and the ball-room without any attempt at improvement; the obstacles to this improvement being few, and easily to be overcome? Oxygen gas is, or should be, very cheap, hydrogen still cheaper. Burning together, these gases produce an intense heat, useful for other applications; but no light. A portion of lime, magnesia, or platinum foil, placed in the flame, gives all that can be required, in point of intensity, for illumination. Surely the distribution and adaptation of this light for any required purpose is not a matter of insuperable difficulty! Where the requisite supply of oxygen and hydrogen gases connot conveniently be obtained, a similar illuminating effect may be produced at no very extravagant cost, by the use of a cheap form of voltaic arrangement.

We had some hopes of the general introduction of the beautiful means of illumination afforded by the lime-light above referred to, when the Universal Lime-light Company (limited), was formed for the purpose of supplying this light under Bastable's and Prosser's patented improvements. The Company, however, do not appear to have made much progress in innovation. We believe that this is attributable in a great measure to the unfavourable aspect in which the new light was exhibited. The

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dazzling sparks of light upon Westminster bridge, in the gallery of the Stock Exchange, and elsewhere, sufficiently proved the intensity of the illuminating power; but by no means gave a pleasing impression of its general effect. No measures were taken to distribute and subdue the intense brilliancy of the focus of light. The general conclusion arrived at by the public was, that the object of illumination is, not to blind the visual organs, but to enable us distinctly to perceive surrounding objects, and that, consequently, the lime light failed in its most important requirement. Nevertheless the management of a source of light to produce the best effect under given circumstances is of comparatively easy attainment. In a pamphlet by Mr. A. H. Renton, C.E., on Artificial Light, the oxyhydrogen lime-light is represented with a large globe of ground glass to intercept and distribute its rays. Even this simple and universally adopted method would probably prove sufficient to give softness to the effulgency of the most vivid sources of illuminating power.

In a physiological point of view every source of artificial light at present in use is liable to the objection, which becomes of special importance in the illumination of public buildings, that it consumes vital air, and replaces it by mephytic gas. The oxyhydrogen lime-light, for which pure hydrogen is employed, is, like the electric light, entirely free from this objection. It appears, however, that coal-gas is employed, in lieu of hydrogen, by the Universal Lime-light Company. Can any difficulty be experienced in obtaining a copious and cheap supply of the latter mentioned gas? The use of carburetted hydrogen is a serious mistake in several points of view. The principal sanitary advantage of the "new light" is destroyed by the evolution of carbonic acid gas, the heat upon which the intensity of the light depends is lowered by the substitution of carbon for hydrogen; and the proportion of oxygen consumed is increased without any corresponding effect. Owing to the shortcomings to which we have referred, the introduction of a light possessing the optical and actinic properties of sunlight, and which also effects no vitiation of our atmospheric pabulum, still awaits the appreciation of science and of the general public.

STANDARDS OF ELECTRICAL MEASUREMENT.

Under the auspices of the British Association for the Promotion of Science, a Commission has been appointed to recommend certain determinate units of electrical measurement for practical adoption among electricians. The necessity for such standards, to which the tension and quantity of a current, and the resistance of a conductor, might be conveniently and intelligibly referred, has long been felt; and there is no doubt that their employment might greatly contribute to the degree of accuracy which is now beginning to be evidenced in the practice of electro-telegraphy. To be of any general utility, however, the proposed system of measurement must necessarily be sufficiently simple and easy of application, to meet the requirements of telegraphists. Glancing at what has already been published in reference to this important subject, we fear there is some danger that a system may be devised, which will be followed exclusively by the eminent gentlemen at whose recommendation it is put forward. That this would be worse than useless, in a practical point of view, need scarcely be insisted upon. The methods of measurement at present in use among telegraphists, however imperfect and miscellaneous, have found favour with those who employ them, and answer their purpose to a certain extent. There is little doubt that they might be perfected, or improved upon, in a general system; but they will certainly not be relinquished for any plan, however perfect in theory, characterised by abstruseness, and difficulty in application.

The step which has been taken to introduce definite standards of electrical tension, static and dynamic quantities, and resistance, was occasioned by the reading of the paper on this subject, by Mr. Latimer Clark and Sir Charles Bright, at the meeting of the British Association at Manchester this year. The object of this paper, which we reproduce in our columns, is obviously, rather to offer suggestions, than to explain a definite system; and we are, therefore, hardly justified in complaining of the absence of details, which would have been of the greatest interest to telegraphists. One of the standards of tension suggested, is a cell of Daniell's battery, which, if the positive element be immersed in pure water, will probably be found sufficiently constant for all practical purposes. To form the unit of static quantity, the poles of this couple may be connected with two metallic discs of determinate area, separated by a certain thickness of a dielectric, such as dry air. The passage through a conductor, in the space of one second, of the unit of quantity accumulated upon the discs, gives the unit of electrical current. The mode of obtaining the whole of this quantity in the form of a current, during a definite period of time, is insufficiently explained, by a reference to the fact, first ascertained by M. Guillemin, and subsequently applied by Messrs. Siemens, that when an uniform succession of rapid discharges is sent through a galvanometer, the deflection of the needle is constant. The unit of resistance indicated, is a wire which will conduct the unit of quantity, and, we presume, *no more*, in the space of a second, under the tension of the single couple of Daniell's battery. The application of the French system of notation in the table, is evidently faulty, the thousandth part of a *volt* being one *millivolt*, and not one kilovolt, as stated. An important feature of this system of measurement, is the mutual relation and dependence of the various units, through which one value may be readily compared with another belonging to a different standard. We shall look forward with interest to some amplification of the principles involved in it, by the eminent practical electricians to whom the above suggestions are due.

MEASUREMENT OF ELECTRICAL QUANTITIES AND RESISTANCE.

BY MR. LATIMER CLARK AND SIR CHARLES BRIGHT.

[A Paper read at the British Association, September, 1861.]

The science of Electricity and the art of Telegraphy have both now arrived at a stage of progress at which it is necessary that universally received standards of electrical quantities and resistances should be adopted, in order that precise language and measurement may take the place of the empirical rules and ideas now generally prevalent. Several standards of resistance have already been proposed, but none have as yet come into universal use, and they have all the disadvantage of being arbitrary in their derivation, or of having no relation to other electrical quantities and measurements. Four electrical standards or units are in reality required; these are mutually dependent on each other, and by their aid every conceivable form of electrical manifestation, whether static or dynamic, and whatever its origin and quantity, can be precisely and definitely stated. They are as follows:—

A. An unit of electrical tension, potential or electromotive force.

B. An unit of electrical quantity, as applied to static electricity.

C. An unit of electric current, or quantity, as applied to dynamic electricity.

D. An unit of electrical resistance.

A.—*The Unit of Electrical Tension, or Electromotive Force.*

It is probable that no more convenient unit of tension could be found than that of a single cell of a Daniell's battery; its electromotive force is but little dependent on temperature, or the strengths of solutions, while the continued deposit of fresh and pure copper makes its force remarkably constant. It is, moreover, a standard which is in constant use, and its energy is so inconsiderable that it would not often require defining fractionally in practice. It is, however, possible to find a more elementary unit. Recent researches have shown, for example, that if a piece of pure zinc be placed in contact with water, or an oxidizing acid, the zinc oxidises, and in doing so instantly gives off electricity, thereby lowering its own tension, and raising that of the liquid. As soon as the two have acquired a certain definite and constant difference of tension the oxidation ceases, and the zinc is no longer attacked. If a piece of copper, or silver, or other less oxidizable

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metal, be placed in mutual contact with the zinc and the liquid, so as to afford a path for the equalization of the tension, the solution goes on constantly, and the continual flow of the electricity from the liquid to the zinc, through the pathway afforded by the copper, forms what is termed a voltaic current. All oxidizable metals have their own specific limit of tension at which they cease to be oxidized, and any of these tensions might be chosen as a unit, but without any practical advantage over that afforded by the Daniell's element. It is scarcely necessary to remark that the unit of tension is equally applicable to static electricity, and to the tensions existing at different points in an electric current. The zero of tension is naturally that of the earth at the place and time being, and the degree may be either plus or minus.

B.—*The Unit of absolute Quantity as applied to Static Electricity.*

There is no natural guide for the formation of this important unit (which is the foundation for the two following), and it is therefore necessary to fix on an arbitrary one. It is well known that the quantity of static electricity—that is, electricity under induction,—varies, *cæteris paribus*, directly as the difference of tension between the induced and inducing surfaces. The quantity is also dependent on two other conditions, the distance of the surfaces from each other, and the nature of the interposed dielectric. Let us, for the sake of argument, assume the dielectric to be dry air, the difference of tension to be equal to that of one element of Daniell's battery, the surfaces to be one millemetre, asunder, and the area to be one square metre; such a standard would be an arbitrary but not an inconvenient one, and to this unit we could refer all other quantities. In practice, this unit would require multiplication by one thousand and by one million. Under this head it is important to observe that any quantity of electricity has a definite existence quite independently of its tension, and when once placed in a body, the tension may be raised or lowered or annihilated, or even reversed in its sign from plus to minus, without any change in its quantity; and when the disturbing causes are removed the quantity remains as before.

C.—*The Unit of Electricity in Motion, or Electric Current.*

Having formed an unit of quantity, the definition of this standard becomes simple and obvious; it is formed by a combination of quantity with time. Thus one unit of electricity passing per second naturally forms an unit of current. The practical formation of this standard presents few difficulties. It has been shown by Messrs. Siemens, that when an uniform succession of rapid discharges is sent through a galvanometer, the deflection of the needle is constant and steady. It is easy, therefore, to send a given number of units per second through a galvanometer, and to compare the deflection obtained with that produced by a constant current from a voltaic couple through a given resistance. This method of determining the standard of conductivity has the advantage of being quite independent of resistances. Although it has not yet been put to the test of experiment, there is no reason to doubt that a given quantity of electricity per second will produce an equal deviation of the galvanometer, whether it flow in a continuous stream or in a succession of minute impulses.

D.—*The Unit of Resistance.*

The standard or unit of resistance should necessarily be the same as that of conductivity or current—that is to say, a wire that will conduct one unit of electricity in one second of time. This would be a very convenient unit for expressing the resistance of the materials used for covering Telegraph Cables; but would be much too large for defining the resistance of telegraph conductors, and it would require subdivision by 1,000 and by 1,000,000, and these resistances would correspond to wires capable of conveying 1,000 and 1,000,000 units of current respectively—that is, wires which would, at the usual degree of tension, conduct 1,000 and 1,000,000 units of electricity per second.

The value of this mutual relationship and dependence will be seen more clearly if we assume a nomenclature for these units, and for this temporary purpose let us derive terms from the names of some of our most eminent philosophers, neglecting for the all etymological rules. We shall then have the following table:—

A.—Tension.

1 Daniell's Element	... = 1 Ohma, or unit of tension.
1,000 Ohmas	... = 1 Kilohma
1,000 Kilohmas	... = 1 Milliohma.

B.—Quantity.

1 Ohma, by one metre square at one milliometre distance ...	= 1 Farad or unit of quantity.
1,000 Farads	... = 1 Kilofarad.
1,000 Kilofarads	... = 1 Milliofarad.

C.—Current.

1 Farad per second	... = 1 Galvat, or unit of current.
1,000 Galvats	... = 1 Kilogalvat.
1,000 Kilogalvats	... = 1 Milliogalvat.

D.—Resistance.

1 Farad per second	... = 1 Volt, or unit of resistance.
1/1000 Volt	... = 1 Kilovolt.
1/1000 Kilovolt	... = 1 Milliovalt.
1/1000 Milliovolt	... = 1 Billiovolt.

The ohma, or unit of tension, is practically a very convenient one for all battery purposes; lower tensions, though not often required, may be readily defined fractionally. The kilohma, or the tension of 1,000 Daniell's cells, is a convenient one for static electricity and for that of induction coils, as it will pass across a small interval of air. The milliohma is applicable to static electricity of very high tension. The farad, or unit of quantity, is as small a one as is likely to be required in practice. Seventy feet of ordinary telegraph wire with a tension of one cell would contain about a farad of electricity. One hundred farad, if allowed to pass through a very sensitive galvanometer, produce a visible motion of the needle. The kilofarad is a good unit for defining the charge or inductive capacity of submarine cables. The galvat, or current of one farad per second, is too feeble to be visible on any instrument, but it is well suited for defining the conductivity of the insulating covering of a mile of cable of the more perfect kinds recently introduced. A kilogalvat would deflect a very sensitive galvanometer about one degree, and is an excellent unit for defining the currents used in practical telegraphy. The milliogalvat is suited for indicating battery currents, and for defining the conductivity of the conductors of submarine cables. The volt, or unit of resistance, is represented by a wire, which would, with a tension of one element, convey a current of one galvat—that is, one farad per second. It would be a useful measure of the resistance of the insulating covering of single miles of cable, although there are some of the most perfect modern cables which offer a still higher resistance. It is, however, altogether too large an unit for the resistance of metallic conductors; it is therefore subdivided into the kilovolt and milliovolt, which last measure is probably small enough to be applicable to the resistances of the conductors of ordinary telegraphic cables. For still smaller resistances it is necessary to have recourse to the billiovolt.

The mutual relation and dependence of these units is seen at a glance—thus at a normal tension, a wire having a resistance of one volt, will conduct one farad of electricity per second, or give a current of one galvat—and similarly a wire having a resistance of one kilovolt will give a current of one kilogalvat, that is, one kilofarad per second; and a wire with a resistance of a milliovolt, will give a current of one milliogalvat or one milliofarad per second; if the tension be doubled or tripled, the quantities will be increased in the same proportion. The practical introduction of this, or some similar system of notation, would be so great a boon to science and to the art of telegraphy, that it is hoped the British Association will lend its assistance and authority for the settlement of the question, and it is suggested that a committee composed of members of the association, should be delegated to examine and report on the whole question at the next annual meeting, with power to confer with English or foreign philosophers, and that funds should be provided for the preparation of standards for public use and reference, a duty in which they would meet with the hearty co-operation and assistance of practical electricians.

THERMO-ELECTRIC CURRENTS IN CIRCUITS OF ONE METAL.

The researches of Seebeck, Sturgeon, Nobili, Bequerel, Matthiessen, Wrede, Magnus, and, recently, of Mr. Fleeming Jenkin, upon this subject, are of considerable interest, and may, at no distant date, receive important applications. It has been established by Magnus* that the action of heat upon an unbroken wire in the same molecular condition throughout produces no current, whatever may be the difference in the diameter of the wire at different points, or the condition of its surface. When, however, the wire is partly oxidised, or partly covered with an electro-deposit of another metal, a current is readily occasioned by the application of heat at one point. The explanation of this phenomenon is probably dependent upon the introduction of two different conductors into the circuit.

In the following instances the production of a current appears to be due to a difference of molecular condition in the conductor, either normal or occasioned by the action of heat.

* Annales de Chimie et de Phisique, 3e série, 1852, tom. xxxiv. p. 105.

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It has been ascertained by Seebeck and Sturgeon, and verified by Matthiessen,* that when the metals bismuth and antimony are cast in the form of a rectangular frame of metal, within or above which a magnetic needle may be pivotted, an electric current is produced by heating the metal in the vicinity of certain points, which are termed neutral points. The direction of the current is changed by applying the heat alternately on either side of these points. In the case of antimony the current traverses the neutral point, from the heated to the cold portion, while the contrary occurs with bismuth. Matthiessen observes that the neutral points are not found in rectangles or prisms of bismuth or antimony which have been allowed to cool slowly after fusion, and in which crystallization has proceeded regularly.

In his experiments on the influence of a difference of hardness in the metallic conductor, M. Magnus employed hard-drawn wires, of which a portion had been annealed, and also annealed wires, of which a part had been increased in density by hammering or by pressure. By heating these wires close to the junction of the hard with the annealed portion, a current was in every case obtained. When the hardened portion was heated, the current was considerably weaker than when the converse operation was performed, and was also in an opposite direction. The following table gives the results obtained with wires of 1½ metre in length. The section of the wire uniting the hardened with the annealed portion was heated to 100° Cent.

Metal.	Direction of the Current.	Deflection of the Galvanometer.
Brass,	from the annealed to the hard portion,	55°
Silver, (1.)	do.	46
Steel,	do.	45
Cadmium,	do.	25
Copper,	do.	18
Gold, No. 1, (2.)	do.	10
Platinum,	do.	5
Gold, No. 2, (3.)	do.	2
Zinc,	from the hard to the annealed portion,	32
Tin,	do.	30
Iron,	do,	4
Lead,	doubtful,	0

The production of the current has been ascribed to the unequal conduction of heat by the two portions of the wire. This assumption appears, however, to be disproved by the experiments of M. Magnus, who found that the conductivity of heat was the same in annealed and hard wire.

It has been shown by M. Bequerel, that when a loose knot is made in a length of platinum wire, or when a portion is twisted spirally, a current passes when the wire is heated in proximity to the knot or the spiral. This experiment has been repeated by M. Gaugain,† who ascertained that the current was not produced when contact was avoided between the portions of wire forming the knot, or between any two concentric twists of the spiral.

M. Bequerel was the first to show that a thermo-electric current may be produced in two wires of precisely the same nature. He connected the two ends of a long platinum wire with the galvanometer, and cutting the wire mid-way, formed two flat spirals of the free extremities. When one of these spirals is heated and superposed on the other, a current immediately occurs in the direction of the cold from the heated wire. In the following table, containing some of the results of the careful experiments of M. Magnus upon this subject; the figures represent the number of degrees indicated on the galvanometer, the sign + that the current travels from the heated to the cold wire, and the sign − that it passes in the opposite direction.

1. Temperature of the wires 8° and 100° per cent.

Metal.	Wires		One wire hard-drawn and the other annealed.	
	Hard-Drawn.	Anncaled.	Hard-Drawn Wire heated.	Annealed Wire heated.
German Silver,	− 40°	− 72	{ − 50 / + 24 }*	− 80
Silver,	− 7	− 8	− 73	+ 68
Copper,	− 8	− 7	− 24	+ 15
Tin,	− 7	− 10	+ 7	+ 20
Zinc,	+ 28	+ 28	+ 62	− 34
Gold,*	+ 5	+ 6	+ 3	+ 5
Gold,†	+ 6	+ 5	{ + 2 / − 11 }*	+ 19
Platinum,	+ 24	+ 22	+ 13	+ 36
Cadmium,	+ 26	+ 15	− 35	+ 55
Pewter,	+ 3	+ 12	− 90	+ 90

* Bibliotheque Universelle de Genève, 1838, tom. viii. p. 358.

† Comptes undus des séances de l'Académie de Sciences, 1853, tom. xxxvi. p. 615.

2. Temperature of the wires 8° and 250° per cent.

Silver, (fine)	− 20	− 17	− 92	{ − 8 / + 90 }*
Platinum,	+ 84	+ 80	+ 90	+ 90
Gold,†	+ 54	+ 31	{ + 10 / − 30 }*	+ 69

The asterisk after the numbers bracketed together denotes a very curious phenomenon of frequent occurrence. The moment after contact is established between the two wires at unequal temperatures, the direction of the current in the above instances changes suddenly. The first figures indicate the deflection upon making contact, and the subsequent number, which is always more considerable, the deflection produced by the second and permanent current.

In our next number will be reproduced *in extenso* the paper of Mr. Fleeming Jenkin on this subject, which was read at the late meeting of the British Association at Manchester.

* Alloyed with copper. † Alloyed with silver.

REPORT OF THE JOINT COMMITTEE Appointed by the Lords of the Committee of Privy Council for Trade, and the Atlantic Telegraph Company, to Inquire into the Construction of Submarine Telegraph Cables.

As we shall have frequent occasion to refer to the Report of the Joint Committee appointed to investigate the subject of submarine telegraphy, the reproduction in our columns of this valuable compendium of facts and opinions, will doubtless be acceptable to most of our readers. Each portion will, when necessary, be accompanied by such observations as may occur to us in connection with the subject matter.

Report to the Lords of the Committee of Privy Council for Trade.

In compliance with the instructions given to us by your Lordships to inquire into "the best form for the composition and outer covering of submarine telegraph cables," we have the honour to inform you that we have made numerous experiments and received the evidence of gentlemen conversant with the subject, and we beg to lay before your Lordships the following report.

In the first place, however, we must express to your Lordships how great was the loss we experienced soon after the commencement of our inquiry by the death of Mr. Robert Stephenson; his philosophical mind, his high scientific attainments, and his great practical knowledge peculiarly fitted him for directing an inquiry such as this, in which mechanical, chemical, and electrical science are combined; it was a subject, moreover, to which he had given considerable attention, and in which he took the greatest interest.

We have, however, had the benefit of his valuable assistance in originally devising the course of our proceedings, and in determining the general experiments which we deemed it necessary to make.

We propose to divide our report into three general heads, viz.:—

I. A short account of the principal telegraph lines which have been laid.

II. The construction and laying of submarine cables.

III. A summary of principles which we consider should govern these undertakings in future.

I.

An Account of the Principal Telegraph Lines which have been laid.

We have appended to this Report a tabular statement, showing the principal submarine telegraph lines which have been laid. (Appendix No. 18.)

In 1840, Professor Wheatstone suggested to the Select Committee of the House of Commons on Railways the construction of a submarine telegraph between Dover and Calais, and subsequently further developed his plans; but the first efficient submarine telegraph which was actually laid was the line between Dover and Calais, projected by Mr. Brett, and completed in 1851.

The tabular statement shows that at the present time 11,364 miles have been laid, but of these little over 3000 miles are actually working.

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The following is a list of these lines:—

—	Length in Statute Miles.	Owner of Line.
Shallow Water Cables.		
Black Sea—Varna to Constantinople	172	Ottoman Government.
Black Sea—Varna to Balaklava	356	British Government.
Corsica and Sardinia	11	French Government.
Dacca-Pegu	116	Indian Government.
Dover and Ostend	80	Submarine Telegraph Co.
Dover and Calais (Grisnez)	25	Ditto.
Folkestone and Boulogne	24	Ditto.
England and Hanover	280	Ditto.
England and Denmark	350	Ditto.
England to Holland, Orfordness, and Schevening (four lines).	119¼ / 118⅛	Electric and International Telegraph Company.
England to Holland, Mismeer to Zandvoort	136	Ditto.
Holyhead and Howth (1854)	73	Ditto.
Holyhead and Howth (1854)	73	Ditto.
Hurst Castle to Isle of Wight	1	Ditto.
Firth of Forth	5	Ditto.
River Tay	1	Ditto.
Holyhead and Howth (1852)	73	R. and S. Nowall & Compy.
Portpatrick and Donaghadee	25	British and Irish Magnetic Company.
Portpatrick and Whitehead	26	Ditto.
Portpatrick and „ (1852)	15	Ditto.
Liverpool to Holyhead	25	Liverpool Dock Committee.
Majorca to Minorca	33	Spanish Government.
Denmark—across the Belt	18	Danish Government.
Denmark, Great Belt	28	Ditto.
Sweden to Denmark	13	Ditto.
Sweden to Gottland	64	Ditto.
Singapore to Batavia	550	Dutch Government.
Tasmania, Bass Straits	240	Australian Government.
Prince Edward's Island to New Brunswick	12	—
Whitehaven and Isle of Man	36	Isle of Man Electric Telegraph Company.
Weymouth to Alderney, Guernsey, and Jersey	93	Channel Islands Telegraph Company.
	3,074	
Deep Sea Cables.		
Athens to Syra and Scio	117	Greek Government.
Atlantic	2,200	Atlantic Telegraph Company
Barcelona to Mahon	180	Spanish Government.
Corfu and Otranto	60	Mediterranean Extension Telegraph Company.
Dardanelles to Scio and Candia, from Scio to Smyrna	514	Levant Telegraph Company.
Iviza to St. Antonia	76	Spanish Government.
Iviza to Majorca	74	Ditto.
Newfoundland and Cape Breton	85	—
Red Sea:— Length Suez-Cossire 294 Cossire-Suakin 545 Suakin-Aden 723 Aden-Kooria-Mooria 825 Kooria Mooria-Muscat 559 Muscat-Kurrachee 553	3,499	Red Sea and India Telegraph Company.
Sardinia and Malta, and Malta and Corfu	700	Mediterranean Extension Telegraph Company.
Sicily and Malta	70	Ditto.
Spezzia and Corsica	110	French Government.
Sardinia and Bona (Cagliari to Ga'ita)	125	Ditto.
Toulon and Algiers	480	Ditto.
	8,290	

It will be perceived that of the lines, above 8,000 miles in length, which are not working, 6,949 miles belong to four undertakings only, viz.: the Atlantic, 2,200 miles; the Red Sea and India, 3,499 miles; the Sardinia, Malta, and Corfu, 700 miles; and the Singapore and Batavia, 550 miles.

We have classed these lines under the respective heads of lines laid in shallow water and deep sea lines. Under the former we place all lines which are at such a depth as to be liable to injury from anchors of ships or dredges, or from strong tidal currents; these may be assumed to be in depths down to about 100 fathoms. Deep sea lines are those which are out of reach of those dangers, in depths considerably beyond 100 fathoms.

The particulars of the condition of the several cables are shown in the tabular statement before mentioned, and we therefore propose only to allude to a small number of the cables.

Shallow Water Cables.

The line between Dover and Grisnez, laid in 1851 by the Submarine Telegraph Company, consisted of four copper conducting wires, each insulated with gutta-percha formed into a rope, covered with tarred hemp, and protected with iron wires of No. 1 gauge. These wires were worked, with occasional injures from anchors, till the spring of 1859, when extensive repairs were undertaken, in the course of which it was found that the gutta-percha covering of the copper wires was in as good order as when first laid, so complete had been the protection afforded by the tarred hemp and the immersion in water. The iron covering was, however, corroded in places, especially where it had lain on a bottom exposed to the action of moving water.

The Submarine Telegraph Company have four other lines between England and the Continent. One from Dover to Ostend, with six conducting wires, laid in 1853, very similar to the Dover and Grisnez cable. In the others, instead of the single copper wire for a conductor, a strand of four copper wires was introduced. Of these, one laid in 1858, between England and Hanover, is 280 miles long, containing two conducting copper strands, and weighing three tons per mile. The other two were laid in 1859—one, a very heavy cable, 24 miles in length, between Folkstone and Boulogne, weighing 9½ tons per mile, and containing six conducting strands of copper wire, insulated with gutta-percha and Chatterton's compound, twisted into a rope and served with tarred hemp, protected by iron wires of No. 0 gauge. The other is laid between England and Denmark, and is 350 miles long, weighing four tons per mile, and containing three conducting strands. The system of the Submarine Telegraph Company has thus been to place all the conducting wires they require for a particular route in one cable.

The lines between England and Holland laid by the International Telegraph Company are five in number. The shallow sea which separates the English coast from Holland is navigated by numerous craft, which renders the submarine lines peculiarly liable to damage from ships' anchors. The shallow water, however, on the other hand, renders the repair or renewal of the lines a matter of little difficulty. Instead of the plan of the Submarine Company, of placing several conductors in one cable being adopted, in the first four lines laid by the International Telegraph Company between Orfordness and the Hague, four single wires were laid in four separate light cables, weighing about two tons to the mile; the four cables were all united to a large and very heavy cable for a distance of three miles from each shore, where ships were thought more likely to drop their anchors. The core is a double-covered gutta-percha wire, wrapped with tape and yarn, and externally covered with No. 8 galvanized iron wires laid spirally. The first cable was laid in a gale of wind; but this cable, as well as the three others, were all successfully paid out, and, setting aside the constant damage from ships' anchors, have generally worked well. The iron wire has, however, been seriously eaten away wherever it was exposed to moving water. It also rusts very fast in places where it rests in the mud on this side the channel, but it has remained uninjured wherever it has been covered with the sand or silt at the bottom of the channel. The cables are sometimes found imbedded to great depths in the shingle on the English coast, and at other times entirely exposed. The lines were so frequently damaged, both accidentally, and occasionally wilfully, that their repair required the almost constant services of a vessel and crew, kept for the purpose; and therefore, to put an end to so serious an expenditure, a large cable with four conducting wires has been laid down in their stead.

The Electric Telegraph Company in laying these four cables left the entire responsibility of the design, construction, and laying of the cables to their own officers, and employed their own vessel, the contractor supplying the cable, and laying it under their instructions.

The Channel Islands Telegraph is worthy of notice. This cable, which is 93 miles long, was laid from Portland to Alderney, Guernsey, and Jersey in August 1858. It consists of a strand of copper wires, forming one conductor, covered with gutta-percha, and protected by iron wires, the weight being about 2½ tons per mile. The

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depth is nowhere greater than 60 fathoms. The cable is laid across a rocky bottom, traversed by a rapid tide; but in parts there is sand and shingle. At the landing place in Jersey the cable is laid among rocks, and the first accident took place there in the month of February 1859. The cable was not fixed to the rocks, and in a violent gale the waves caused it to strike repeatedly against the rocks, and broke it. A repetition of this injury was prevented by clamping the cable down to the rocks by means of iron forks leaded into the rocks. The next accident occurred eight months after the laying of the cable four miles from the island of Portland, where the tide, which runs at five or six miles an hour, had caused the cable to work upon a ridge of rock in 25 fathoms water, which had worn it through; in repairing this the cable was taken up and relaid over shingle in another place. In other parts, where the iron covering of the cable was exposed, it became corroded, the rust which formed being continually washed away; in other places, when it rested on cement stone the wire was decayed, and in some cases the cable sunk into the cement stone; another cause of corrosion is stated to be the attachment of zoophytes and vegetation to the cable.

In one case the cable was so much abraded on rocks, that half the gutta-percha and three inches in length of copper wire was laid bare and worn away, leaving only an oxide of copper exposed to the water in the groove in which the copper had lain; and defective as this portion was it is stated that weak currents could still be passed through the cable. Another fault appears to have occurred from lightning. A thunderstorm took place in Jersey, and the lightning is said to have struck the wire on the land; a portion passing into the office, and destroying the instruments; another portion passing out in the land wires and producing small punctures; the remainder travelling 16 miles along the cable to within two miles of Guernsey, where it appears to have met with a weak place, and passed out into the water, producing a fault.

Further particulars of the other cables will be found in the evidence and Appendix No. 18; and we propose, therefore, only to allude to two others. One was laid between Singapore and Batavia, for the Dutch Government, which weighed 21 cwt. per mile, and is similar in construction to the Red Sea cable, a cable which had been devised for a deep sea line. (See Table in Appendix No. 18.) This line has failed, partly in consequence of injuries from anchors, and partly from corrosion of the outer covering, which was too weak for a shallow water cable.

The other was manufactured by Mr. Henley, and laid by the Tasmanian Government, across Bass's Straits in 1859, in three sections, and weighed 2 tons per mile. One section has failed, and is to be replaced by a stronger cable. This section was abraded by the rocky bottom on which it was laid. On the same section a seaweed called kelp grows profusely, which, it is stated, enveloped and floated the cable in some places. The new line is proposed to be laid on a good sandy bottom, in an altered direction, which, had a careful preliminary survey been made, would have been selected at first, and would have prevented the failure which has occurred.—*(To be continued.)*

THE EFFECT OF EXTREME PRESSURE ON WATER.

The following experiments upon the effect of a pressure of 3 tons on the square inch upon water in hydraulic pipes or tanks, are important, as bearing upon the correctness of the tests for insulation on covered telegraphic wires.

FIRST EXPERIMENT.

Temperature of water in the well of the hydraulic pump	62°
Temperature of the hydraulic pipe, containing the insulated wire, externally	64°
Temperature of water forced from the well into the pipe, after the application of pressure (3 tons per square inch).	76°

SECOND EXPERIMENT.

8 P.M.

Temperature of water in well	65°
Temperature of pipes	60°
Temperature under pressure	76°

THIRD EXPERIMENT.

7 A.M.

Temperature of water in well	62°
Of water left in pipes overnight.....	61°
Temperature of pipes externally	56·5°
Temperature of water after pressure	70°

It appears from a work published in the early part of the present century, that the Florentine academicians filled a globe of gold with water; this they compressed with a very violent force, and the act of compression was found to have considerably heated the water.

General Financial Retrospect.

Friday Morning.

A RAPID approach is making to that state of ease in the Money Market, which is supposed to indicate that an era of speculation may not be far distant; but the circumstances which govern the existing position of things, is widely different to that usually experienced when a mania in reality occurs. The present plethora of capital arises from the general stagnation of business, primarily produced by the disruption of our American relations, further assisted by the unsettled nature of politics on the Continent, and the transition through which the commercial community is passing in conjunction with the operation of the French treaty. The non-employment of capital therefore, causes balances to accumulate in the hands of the Bankers and Brokers; but although this abundance exists, there is not confidence enough to stimulate activity, or to encourage investments in securities other than those of the first class, or most convertible nature.

But while this is the case in England, the condition of the market in France presents quite a contrast. Instead of the Bank rate being there 3 per cent., as with us, the reduction of a-half per cent. having been made by the Threadneedle Street authorities yesterday, it is 6 per cent., the purchases of grain to supply a deficient harvest, and the support given to the late Italian loan of £20,000,000, having pressed heavily on resources, and the prospects of the next three months are anything but favourable for Parisian capitalists. Then with American trade suspended, which probably affects France in a greater degree than ourselves, the tendency to a high rate of discount across the Channel is likely to be maintained. The knowledge of this circumstance, and the exceptional position of Austria and Italy, must necessarily induce correction, and arrest any undue progress to the development of illegitimate adventure. The issue of events will, however, be quite the opposite should an undisturbed accumulation of capital take place. Then the seeds of speculation might germinate; thus great activity in produce might follow; and finally a very low and continuous rate of discount might terminate in the fructification of projects possessing neither basis of success or reputation to support them.

Apart from the operations in cotton, corn, and rice, there is nothing to lead to the impression that the markets for the principal articles of foreign or colonial productions are in unhealthy condition. The cotton market, after being dull, has temporarily revived, the advices from America being unsatisfactory as to the maintenance of peace with England. Besides, the half per cent. drop in the rate of the Bank of England would give fresh hope to the ready speculator. The grain market is again acquiring firmness, in consequence of the belief that France will not only be short in her supply, but that our own growth will be insufficient without liberal imports from abroad. Whenever there is a movement in corn, rice to an extent sympathetically advances.

The Bank having reduced its *minimum* terms of discount to 3 per cent., the bill brokers now only allow 2 per cent. for money at call, and 2¼ per cent. for deposit at 7 days notice. The allowance by the Joint Stock Banks is in all cases limited to 2 per cent. It would appear by the *Gazette* return of the state of the national establishment that it has scarcely varied in essential points from last week, and that the lowering of the rate might as well then have been accomplished as yesterday. Meanwhile the result is the important fact that the position of the Bank of France has improved.

With the present abundance of money, and the absence of regular channels for its employment, the prices of stocks and shares have been fairly sustained. A good average business has been transacted, and without any great amount of activity. Consols, Indian securities, and foreign bonds, like Mexican and Buenos Ayres, affected by special circumstances, have advanced. The Bank movement of yesterday gave additional firmness to

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English stocks and India 5 per cents., and the prices last week of the former for the December account were 92 to $\frac{1}{8}$ ex-dividend, equal to $93\frac{1}{2}$ to $\frac{5}{8}$ with dividend; and of the latter $105\frac{1}{2}$ to $\frac{3}{8}$. So easy were the terms for advances that the rate on consols for a few days was $1\frac{1}{2}$ per cent., and for the period of a month 2 to $2\frac{1}{2}$ per cent.

The success of the Buenos Ayrean forces over Urquiza their opponent has driven the price of that stock to 90 to 91—a rise of 4 or 5 per cent. Mexican has recovered its late fall, and improved again to $27\frac{3}{4}$ to 28. Spanish certificates have, the last day or so, been all the vogue, the quotation being $6\frac{1}{4}$ to $\frac{3}{8}$.

The Railway market has been occasionally animated, but prices have drooped, through the expectation that the winter months will uniformly influence traffic, especially with the state of things in the Lancashire districts. Midland, and Lancashire, and Yorkshire, have still been comparatively good; and South Eastern are lower, having been interfered with by the London, Chatham, and Dover Company. Lombardo-Venetian among the foreign lines have improved, it being considered that the traffic will not be interfered with by war this winter.

The meeting of the Red Sea Telegraph Company has ended, as it might be presumed it would, in a satisfactory manner. The Government have meted out tardy justice to the share-holders, and the shape of the compensation is not in the least objectionable. No question can be entertained but that the new Company will succeed, and the the old proprietors are not likely, we should think, to let the general public absorb many of the shares which are to be secured in that project. This under-taking is placed on a good foundation, and, with prudent management, an important result will be attained The price is $18\frac{3}{4}$ to $19\frac{1}{4}$; the quotation ought to be better than this. United Kingdom Telegraph Company are $\frac{1}{2}$ discount to par; Electric Telegraph Company 95 to 98; and Mediterranean Electric Telegraph 3 to 5.

MAGNETIC AND DIA-MAGNETIC COPPER.

The following is quoted from Professor Tyndall's paper, *On the Absorption and Radiation of Heat by Gases and Vapours.*

"At an early stage of the investigation, I experienced the necessity of a first-class galvanometer. My instrument was constructed by that excellent workman, Sauerwald of Berlin. The needles are suspended independently of the shade; the latter is constructed so as to enclose the smallest possible amount of air, the disturbance of aerial currents being thereby practically avoided. The plane glass plate, which forms the cover of the instrument, is close to the needle; so that the position of the latter can be read off with ease and accuracy, either by the naked eye or by a magnifying lens.

"The wire of the coil belonging to this instrument was drawn from copper obtained from a galvano-plastic manufactory in the Prussian capital; but it was not free from the magnetic metals.

"In consequence of its impurity in this respect, when the needles were perfectly astatic they deviated as much as 30° right and left of the neutral line. To neutralize this, a "compensator" was made use of, by which the needle was gently drawn to zero in opposition to the magnetism of the coil.

"But the instrument suffered much in point of delicacy by this arrangement, and accurate quantitative determinations with it were unattainable. I therefore sought to replace the Berlin coil by a less magnetic one. Mr. Becker first supplied me with a coil which reduced the lateral deflection from 30° to 3°.

"But even this small residue was a source of great annoyance to me, and for a time I almost despaired of obtaining pure copper wire. I knew that professor Magnus had succeeded in obtaining it for his galvanometer, but the labour of doing so was immense. Previous to undertaking a similar task, the thought occurred to me that for my purpose a magnet furnished an immediate and perfect test as to the quality of the wire. Pure copper is dia-magnetic; hence its repulsion or attraction by the magnet would at once declare its fitness or unfitness for the purpose which I had in view.

"Fragments of the wire first furnished to me by M. Sauerwald were strongly attracted by the magnet. The wire furnished by Mr. Becker, when covered with its green silk, was also attracted, though in much feebler degree.

"I then removed the green silk covering from the latter and tested the naked wire, *it was repelled.* The whole annoyance was thus fastened on the green silk; some iron compound had been used in the dyeing of it, and to this the deviation of my needle to zero was manifestly due.

"I had the green coating removed and the wire overspun with white silk, clean hands being used in the process. The needle, when released from the action of the current, returns accurately to zero, and is perfectly free from magnetic action on the part of the coil. In fact, while we have been devising agate plates and other elaborate methods to get rid of the great nuisance of a magnetic evil, the means of doing so are at hand. Nothing is more easy to be found than dia-magnetic copper wire. Out of eleven specimens, four of which were furnished by Mr. Becker, and seven taken at random from my laboratory, nine were found dia-magnetic, and only two magnetic."

THE GASEOUS COUPLE OF PROFESSOR GROVE.

More than eighteen years have elapsed since it was shown by Grove that oxygen and hydrogen gases confined over water in contact with strips of platinum constitute the elements of a powerful voltaic arrangement. In point of theory, the gaseous couple possesses the highest degree of interest, as it explains, more perfectly than any other apparatus, the phenomena of the polarisation of battery plates and the theory of electrolysis. Little has been done to effect its application in practice; but the fact that the employment of this arrangement necessitates the consumption of oxygen and hydrogen only, is sufficient to prove that its use on a large scale might be attended with important economic advantages. We will, therefore, endeavour to give such instructions as may enable the student of electricity to construct couples of this description without any great expenditure of labour. The principal difficulty of manufacture is the platinisation of the strips of platinum which are employed for the poles of the battery—an operation which, however, is readily effected by electro-deposition.

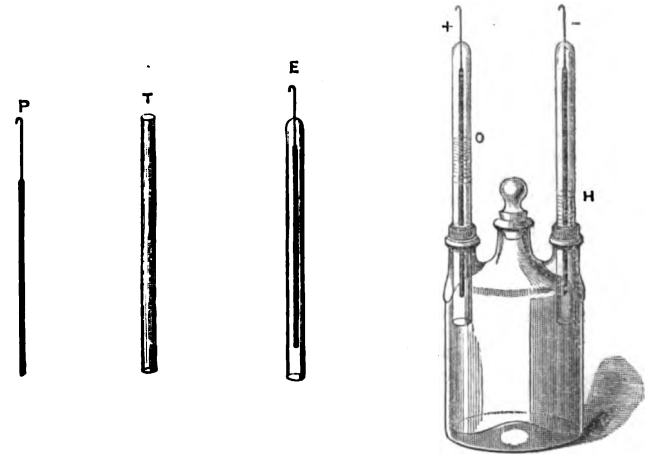

Fig. c represents the couple complete, the tubes containing the two gases being inserted in the side tubulures of a three-necked Woolf's bottle. To form these tubes, the platinum wire P is flattened upon an anvil for the greater portion of its length; and upon this portion platinum in a state of fine division is deposited from a solution of the metal, in which the platinum strip forms the negative electrode of a weak voltaic arrangement. The platinum strip is then inserted in the glass tube T, the extremity of which is then scaled round the wire before the blowpipe, as in Fig. E. The tube is then inserted in a cork fitting the tubulure of the bottle.

To arrange the couple, the bottle, with the tubes inserted in the tubulures, may be nearly filled with water acidulated with sulphuric acid, and the stopper being replaced, inverted so as to fill the tubes. By means of flasks with bent tubes attached, from which the gases are evolved, the tube may now be filled with oxygen and hydrogen, sufficiently to allow the lower extremity of the platinum strips to remain in contact with the acidulated fluid. The exposed extremities of the platinum wires form the poles of the couples, that which is in contact with the oxygen forming the positive, and the wire in contact with the hydrogen the negative pole.

With a single gaseous couple thus constructed, the electrolytic

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decomposition of iodide of potassium in solution may be effected. The tension of the current from four, or even from two couples, is sufficient to decompose acidulated water.

The chemical actions upon which the efficiency of the couple depends take place at the surfaces of contact of the gases, the fluid, and the platinum strips. Under the influence of the gaseous masses and the portions of platinum, the molecules of the water become polarised, and the fluid is decomposed, the oxygen being discharged from the platinum within the tube containing the hydrogen, and the hydrogen from the platinum of the oxygen tube. But in the tube H, the nascent oxygen at the surface of the platinum meets with gaseous hydrogen, with which it combines; and a similar action takes place within the other tube. For each equivalent of water decomposed within the bottle, an equivalent of water is therefore formed in each of the tubes, the result being the same as if the hydrogen of the tube H had combined directly with the oxygen of the tube O. In this couple the positive metal is replaced by the positive hydrogen, the negative fluid by the negative oxygen.

In the electrolysis of water, whatever may be the number of couples, united by their opposite poles, employed, the quantities of oxygen and hydrogen gases produced are found to be equal to those which have disappeared from the tubes of *each* couple. This experiment, therefore, beautifully establishes the fact, which has been questioned even by some modern writers upon voltaic electricity, that the *quantity* of the current is not increased by the number of alternations which determine its *tension*.

It is an interesting fact, that the presence of nitrogen, or of its protoxide, in admixture with either the oxygen or hydrogen of the couple, completely destroys its efficacy. The oxygen, however, may be in admixture with a higher oxide of nitrogen, with olefiant gas, or with carbonic oxide, although with the latter the action is weakened considerably. The couple formed by chlorine and carbonic oxide gases gives a powerful current, the latter gas being the positive element. Powerful couples may be formed with a gas and a fluid capable of acting chemically upon each other, such as hydrogen and nitric acid. In this case the nitric acid is decomposed into a lower oxide by the hydrogen, the latter forming the *positive* element of the couple.

EARTH CURRENTS.

The operations of telegraphy are periodically, to a more or less extent, interrupted by what are generally designated, earth currents, magnetic storms, and other electrical phenomena. Mr. Cromwell Varley, in his reports to the Astronomer Royal (see Appendix to the Report of the Submarine Telegraph Committee), supplies some very interesting facts in illustration of the subject. The deflections, as observed at various times and places, are exceedingly capricious. For example, on 29th August, 1859, the deflections observed at Lothbury, the Company's central office, were as follows:—

From earth at			To earth at			Circuit at London.
Southampton	...	...	London	...	...	— or N
Brighton	...	...	Ditto	...	...	+ or P
Ipswich	...	...	Ditto	...	...	+ or P
Yarmouth	...	...	Ditto	...	...	+ or P
King's Lynn	...	...	Ditto	...	...	+ or P
York	...	...	Ditto	...	...	+ or P
Derby	...	...	Ditto	...	...	— or N
Manchester	...	...	Ditto	...	...	— or N
Portsmouth	...	...	Ditto	...	...	— or N

The Astronomer Royal, in his interesting paper read before the British Association at Manchester, "On Spontaneous Terrestrial Galvanic Currents," makes the following observations upon the subject:—

"It being now a well ascertained fact, that spontaneous galvanic currents have in several instances prevented the working of the telegraphic wires, the matter had become one of so much importance, that he had felt the necessity of steps being taken to ascertain the exact cause of these disturbing influences. With this view, he had placed himself in communication with the telegraph companies, but had not been able to obtain much information from them, probably in consequence of their not having the leisure to note down observations on the effects produced on the telegraphic wires. His wish was, to have a constant registration of the effect of these galvanic currents, at the Royal Observatory, and he believed that all that was required to ascertain the causes of these spontaneous disturbances, was the laying down of an insulated wire. The Government had acceded to his proposal, and he thought it his duty to state, that on the part of the Board of Visitors, there was the most anxious wish expressed, that the object he had in view should be carried out. In all these instances the Government had acted towards him with the greatest liberality. He (the President) had been in communication with Dr. Lamont, of Munich, and had received the following communications from him on the subject, which he had thought it desirable to have printed for the members of the Association, but not necessarily for circulation amongst the public generally. In one of his communications Dr. Lamont said, 'Since the beginning of last year, I have been occupied with the investigation of the electric currents observed in telegraph wires, and have obtained various results; the most remarkable of which is this, that electric currents, or, as they may be more properly termed, electric waves, varying in direction and intensity, are constantly passing at the surface of the earth, and that these waves correspond perfectly with the variations of terrestrial magnetism; a wave directed from north to south producing an increase of westerly declination, and a wave directed from east to west producing an increase of horizontal force. I have employed wires of different lengths, and metallic discs of different sizes and at different depths underground—in all cases the currents are the same, but their intensity depends on the size of the discs and the length of the wires, or rather the distance at which the discs are placed from each other. A distance of 400 feet is sufficient, if the discs are large enough. To show the effects satisfactorily, the instruments must be of a peculiar construction; ordinary galvanometers and magnetometers will not answer; besides, various other conditions are to be observed.' And in another communication he stated that, 'The currents observed in telegraph lines are due partly to the agency of chemical causes (oxydation of the discs and other parts of circuits), partly to thermal causes (thermo-electricity, expansion, &c.), partly to terrestrial electricity. The variations of terrestrial electricity can only be obtained while the chemical and thermal causes remain constant. The effect of the chemical causes changes very slowly; the effect of the thermal causes can be considered as constant only in calm weather, and for very short intervals of time (say two or three minutes), when the wires are of moderate length and suspended in the air; for longer intervals if underground. I believe that lines above 1000 feet in length, if not underground, are of no use for the investigation of terrestrial electricity, because under all atmospheric circumstances the disturbances produced by thermo-electric currents will be too great.' It appeared to him, with very great submission to Dr. Lamont, that they need not, necessarily, be bound or restricted to the limits which he suggested. As the disturbances affected long lines of telegraphic wires, it appeared to him that their attention ought more particularly to be directed to these long lines. He had brought the matter before the section with the view of inviting discussion upon it. He should be happy to hear from the section, whether they were prepared to adopt the views of Dr. Lamont or his own, which, he might say, he had now power from Government to carry out. He should be glad if any gentleman would throw out suggestions on the subject. He would not bind himself to act upon them, but at the same time, they should have his best attention."

Professor Thomson, F.R.S., in his evidence before the Government Submarine Telegraph Committee, also furnishes some highly interesting information respecting the action of earth currents, &c., upon the submerged Atlantic cable:—

"Continually varying earth currents, not such as would have embarrassed signals, were observed. After the failure of the cable, I found that those earth currents could be balanced by opposing a certain measured battery electro-motive force against them. I arranged a little instrument for the purpose, which was made in the workshop there, to facilitate the reading of messages, which were still expected long after the cable failed. By this instrument I could show any fraction of the electro-motive force, of one, two, or three of Daniell's cells, that might be necessary to balance the earth currents. This instrument would have been useful if the messages had come; as it was, it only sufficed to give me a precise measure of the electro-motive force of the earth currents in terms of that of a cell of Daniell's battery. The electro-motive force seldom reached two cells, generally was less than that of one cell; sometimes positive, sometimes negative. When a copper-plate earth was used, there seemed to be nearly as much positive as negative; and when an iron earth was used, the positive earth currents preponderated considerably, but still there would be occasionally negative currents. As the fault amounted, at this time, undoubtedly to very nearly a perfect earth communication, at some such distance as 250 miles in a right line, I concluded that the electro-motive force between two copper-plates buried, the one at Valentia, and the other buried in the sea 250 miles west, varied between such limits as I have stated, namely, generally, whether positive

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or negative, falling short of that of two cells of Daniell's battery, and most frequently less than that of one cell; sometimes reaching five or six cells, but that very rarely. I may mention also, as another circumstance of interest, that on one occasion, (near midnight of Monday evening, August 24th,) while waiting for signals from Newfoundland, the mirror was found to be violently deflected at Valentia, so much so, that it had the appearance of being broken from its suspending thread; it turned out to be simply, that the mirror was pressed forcibly against the stop, at the extreme end of its range. While I was looking into the mirror, to ascertain whether there was any such accident, it suddenly turned round and went to the other side, there being no battery applied at all at the Valentia end. When communication was re-established, I asked what was wrong, and was told that a violent thunder-storm had been experienced at Newfoundland. 'Great deflections and end put to earth for half-an-hour;' this precaution having been very properly taken by the director of the station there, to prevent the possibility of damage to the cable from lightning."

With a view to ascertain the cause of these remarkable phenomena, a series of experiments were made upon the grounds of the Government Experimental Committee, at Gloster Road, in 1859,-60, and -61. Two miles of copper wire, No. 16, were suspended 15 feet above ground upon poles, and insulated by glazed porcelain inverts and terminals, the distance of the poles apart being 330 feet. It was of considerable advantage, during the progress of experiments, to have the wires within sight, so that their condition at all times might be easily watched and examined. The investigations embraced the influence upon the suspended wires of sunshine, clouds, rain, fog, frost, wind, steam, smoke, &c., and also the peculiar character of currents generated by introducing various dissimilar metals as earth plates, such as water-pipes, gas-pipes, iron, steel, zinc, tin, lead, charcoal, copper of superior and inferior quality, &c.

(To be continued.)

THE PANTELEGRAPH.

A DESCRIPTION of a machine under the above designation appeared recently in the columns of the *Times*, and which we have transferred into our own, has attracted considerable attention on the part of those interested in telegraphic process. It is stated that the contrivance is of "Italian growth," and that the French Emperor, before whom it has been exhibited, assured the inventor that the "Pantelegraph did great honour to Italy, and was a discovery of which France herself might be proud." We are, however, reluctantly compelled to question the correctness of the statement as to the Italian origin of the discovery. It is well known that Mr. Bakewell some years ago patented a very beautiful arrangement, similar to that now claimed by Casselli, and which has often been referred to in various scientific journals. One of such instruments was, we believe, exhibited at the telegraph *soirée* of the British Association at Manchester.

Further, a Mons. Fossarieu exhibited about three years ago, an instrument of like construction at the office of the *Moniteur*. Although there may be some difference in the mechanical arrangements—the identity of principle, is evident in each case.

The following is the paragraph from the *Times*, to which we have referred.

"CASSELLI'S Pantelegraph is now attracting much attention at the Italian Exhibition in Florence, vindicated as originally of Italian growth. Nothing, says the *Times* correspondent, in the whole of the vast department of the Exhibition devoted to machinery, struck me as more wonderful than Casselli's Pantelegraph. The illustrious inventor has established a communication between Florence and Leghorn, and himself attends at the Crystal Palace to exhibit the results of his portentous contrivance. He has the pale countenance, the feeble frame of the student; the deep look of concentration of the thinker, the modesty and gentleness of a man of real worth. He was a disciple of Nobili and Amici, those distinguished natural philosophers who have done so much for the increase and diffusion of electro-magnetic science. His Pantelegraph, as is generally known, is intended for the transmission of messages immediately from the hand of the writer, conveying a fac-simile of every word and syllable, and bearing the full authenticity of the hand and signature. A banker at Paris or London may thus, hereafter, draw a check upon Turin or Florence, which his correspondent will honour at sight, being as sure of the identity of the document as if he had the very paper on which it is written. I have looked on for some time on the working of this apparently magic machine, and have seen it write under my inspection now three, now four lines of *Dante* in the very handwriting with which the correspondent was at that very moment tracing them on the prepared paper in Leghorn. Presently a lineal drawing of a portrait of Dante, which was being delineated at Leghorn, came into life before me, line by line, shade by shade. Anon, again, it was a pattern design for a lady's embroidery. In one word, it is the reproduction, at a distance, of anything that pen or pencil can produce. A small point, somewhat like the hand of a watch, runs semicircularly, moved by a very simple machine, upon a chemically-prepared paper, tracing almost invisible lines, the aggregate of which soon embodies the words line by line, or the various parts of the design till the whole stands before us. The action is so rapid that the average transmission is of 12 words in a minute, being somewhat quicker than the usual mode of telegraphic communication, with the avoidance of all possible mistake or equivocation. Casselli has exhibited his invention before the French Emperor, who assured him, 'The Pantelegraph did great honour to Italy, and was a discovery of which France herself might be proud.' A communication between Florence and Paris is soon to be established."

In the year 1858, the following description of the apparatus of M. Fossarieu appeared also in the *Times*.

"CURIOUS ADAPTATION OF THE ELECTRIC TELEGRAPH.—A curious apparatus, the invention of M. Lucy Fossarieu, was tried a few days ago at the office of the *Moniteur*. The inventor's object is to reproduce with mathematical precision an exact facsimile of the handwriting, as well as the substance of a dispatch. The apparatus consists of two parts, viz., the manipulator, by which the dispatch is transmitted, and the receptor, by which it is received. The manipulator is composed of a shaft, to which an alternate motion is communicated by means of a crank, the connection rod of which revolves once in two seconds. At every motion of the shaft a bar, which is made to rest upon it by means of a spring, is separated from it by the passing of a cog fixed to a revolving wheel. This bar has a metallic point or stylus at its extremity, which is in direct communication with the pile, and moves on a plate of copper on which the dispatch has been written with a kind of ink which impedes the transmission of the magnetic current. The other portion of the apparatus, the receptor, is set in motion by a crank exactly similar to the former, and revolving in the same space of time. It is, moreover, provided with an electro-magnet, acting upon a moveable lamina, which is attracted each time a magnetic current passes. This lamina ends in a pen or pencil, which traces the characters transmitted, on a piece of common paper. The action of the apparatus is now easy to understand. As soon as the stylus of the manipulator begins to move on the copper plate, a magnetic current is established, and the electro-magnet attracts the lamina, keeping it away from the paper. But no sooner does the stylus reach the writing, which interrupts the magnetic current, than the electro-magnet loses its attractive power, and lets go the lamina, which falls with its point upon the paper, and marks a trace upon it. The wonderful identity of the copy thus obtained with the original can only be compared to that which could be produced by photography. In previous inventions tending towards the same end as the one described, one of the chief inconveniences was, the necessity of using chemical paper, which had to be kept moist all the time; a condition which could not easily be fulfilled, especially in summer; so that the transmission of a dispatch was often interrupted. In M. Fossarieu's system any kind of paper may be used, without any previous preparation, and without any necessity for moistening it."

COLONIAL TELEGRAPHY.

THE whole of the telegraphic extensions carried out under the votes of the Legislature last year, are now complete; and are all, with one exception, available for the transmission of messages.

The superintendent of telegraphs has just returned from the southern districts of the colony, which he visited for the purpose of opening the extension from Gundagai to Deniliquin. This line, which passes through Wagga Wagga, is connected with a private line from Deniliquin to Echucha, where there is a junction of the Victoria and South Australian wires, by way of Castlemaine and Ballarat.

There is consequently now a separate line of communication with Melbourne and Adelaide, which may be made available for messages in the event of an interruption upon the other lines southward of Gundagai.

The line between Deniliquin and Echucha, was constructed by a private company, from whom it has been purchased by the Government at its original cost, which, with the office furniture and instruments, will amount to £2,820.

Upon the opening of the new line, which took place the first week

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in this month, a message was transmitted from the minister of public works, congratulating the inhabitants of Deniliquin on the opening of a telegraph line, which would place them in immediate communication with the most important points of the colony, as well as with the neighbouring colony of South Australia, and shortly with Queensland.

The second portion of the northern extension, from Munurundi to the northern boundary of the colony, is now finished. In a few days the instruments will be taken up, and the line opened to Armidale, or probably to Tenterfield. There has been considerable delay in the continuation of the wire to Brisbane on the part of the Queensland Government; otherwise we might by this time have had a system of communication, uniting the four colonies. For this desirable event we shall have to wait about two months longer.

Of the two telegraphic extensions, for which money was voted last session, only one is being proceeded with. The line from Goultran to Braidwood, a distance of 60 miles, was commenced about six weeks ago, and a length of about 20 miles is completed. The line is to be ready for opening next April, but will probably be finished considerably before that time.

The other extension—that from Deniliquin to the frontier of South Australia—has not yet been put in hand; and there seems a doubt whether it will be proceeded with. As it was only intended as an auxiliary line, so as to be available for communicating with Adelaide during a stoppage upon the existing line, its construction is not regarded as a matter of much urgency.—*The Sydney Morning Herald, August*, 1861.

RED SEA AND INDIA TELEGRAPH.

[From the TIMES.]

A SPECIAL general meeting of this company was held on Tuesday last at the London Tavern, for the purpose of considering a proposal received by the Board from the Lords Commissioners of the Treasury, for the transfer of the line and property of the company to Her Majesty's Government. Mr. MARSHMAN in the chair.

Mr. C. L. PEEL, the secretary, having read the notice convening the meeting,

The CHAIRMAN said the object of the meeting was fully stated in the notice. The directors had been endeavouring to obtain from the Government some arrangement for the repair of the line, but the Lords Commissioners of Her Majesty's Treasury had not deemed it expedient to grant any further guarantee for that purpose. Some weeks ago it was proposed to form a new company for the purpose of raising sufficient capital to repair the whole of the line, and render it of service to the public. A communication to this effect was immediately sent to the Lords of the Treasury, which resulted in a proposal to the effect that Her Majesty's Government was disposed to exercise the right of taking over the line from the company, and of repaying the whole of the capital to the shareholders. The directors stated, in reply, that they had reason to believe that the shareholders would be equally satisfied with having an annuity of 4½ per cent. secured to them, payable at the Bank of England. To this proposal the Lords of the Treasury gave their consent, and expressed their willingness to take the line and relieve the directors from their responsibility. He then read the following letter, which was addressed to the directors by the Secretary to the Treasury :—

[illegible] October 15, 1861.

[illegible] concern to the hands of a new company, on suitable terms and conditions, should any such company be formed with an amount of capital sufficient to justify a reasonable hope of the success of its object.

"2. To convert the present guarantee into a Government annuity of like amount, payable at the Bank of England, as in the case of other Government annuities.

"It would follow from this conversion that all expenses of disbursements would be defrayed by the Government.

"3. To reserve power to the Government to redeem this annuity at any time hereafter, on payment of a capital sum in proportion to the unexpired period which the annuity may then have to run.

"Your Board is, of course, aware that no final step can be taken in such a matter without the approval of Parliament, but my Lords undertake, on the part of Her Majesty's Government, in the event of such new company being established, to have a Bill introduced into Parliament early in the ensuing Session, for carrying into effect the foregoing terms.

"Their Lordships abstain, on the present occasion, from entering into details connected with the proceedings of the new company, leaving them for future discussion and arrangement.

"I am, &c.,
"G. A. HAMILTON."

On reading this letter the directors thought the third clause was rather obscure, but might be agreed to with the understanding that a full and fair equivalent should be given to the shareholders in case the Government should exercise their option of redeeming the annuity. Several large shareholders objected to the third Clause, and eventually a deputation from the directors had an interview with the Chancellor of the Exchequer on the subject, and some days after there was a meeting of the largest shareholders, and it seemed to be the general opinion that the proprietors should accept the annuity with the understanding that the sum to be paid them in case of redemption should be sufficient to enable them to purchase a Government annuity of equal value. Upon this point there was no difference of opinion between the Chancellor of the Exchequer and the directors that a full and fair equivalent should be given to the proprietors, and that they should not suffer the slightest disadvantage at any future time by the redemption of the annuity. The details would of course, be left to the directors. He concluded by moving the following resolution :—

"Resolved, that the proposition mentioned in the letter addressed by the Secretary of the Treasury to the directors of the Red Sea Telegraph Company on the 15th of October last be and is hereby accepted, on the understanding that it be made clear in the agreement with the Government that the intention of Clause 3 in the proposal is, that in the event of the Government deciding to redeem the annuity, they shall pay a capital sum which will be sufficient to purchase a Government annuity of 4*l.* 10*s.* per cent. per annum on each 100*l.* of the stock or capital of the company for the unexpired residue of the term."

Mr. DENT, a director, seconded the motion. He said the proposal had been fully discussed by the directors; they considered that nothing but a Government annuity could be equal to a Government annuity, and the Board of Directors unanimously recommended the adoption of that resolution.

A discussion then ensued, in which Mr. A. Eames, Mr. T. K. Cleghorn, Mr. Skinner, and other shareholders took part, in the course of which the resolution was adopted, there being only two dissentients.

The CHAIRMAN then moved the following resolution :—

"Resolved, that the directors be, and they are hereby, authorized to take all necessary measures for carrying the arrangement into effect."

Mr. DENT seconded the motion, and it was carried unanimously.

The CHAIRMAN said that Sir Macdonald Stephenson, the chairman of the new company—namely, the Telegraph to India Company, wished to address the meeting. (Hear.)

Sir MACDONALD STEPHENSON said he hoped they would permit him to congratulate them upon their decision to accept the Government proposals, with the interpretation of the only point on which any doubt could arise sufficiently defined to prevent possible future misapprehension. He would make a few observations on the subject of the new company, which he hoped and believed would not be entirely without interest, the more especially as the carrying out of the new company was one and an essential condition in the Government arrangement. Telegraphic communication between Great Britain and her vast dependencies in the East, had long been an acknowledged and imperative necessity, and corresponding exertions had from time to time been made to accomplish it. Immediate success rarely attended any great innovating enterprise. It was a gradual and progressive operation, attained only after repeated failures had furnished the experience upon which ultimate success could be hoped for. The greater the undertaking the greater the difficulties usually encountered, and the greater should be the resolution and perseverance exercised to overcome them. It was no new theory, it was the thought, language, and action of every Englishman under the same circumstances. It must only be the right thing to be done, and neither time, trouble, nor money would be spared to accomplish it. The telegraph to India would not require any illustration to demonstrate its value to all classes. Additional lines would assuredly be required within a few months of the restoration of the first. One merchant assured him that he should have saved £50,000 if he could have sent a single message. The Peninsular and Oriental Company's reports of their ships were of hourly necessity. The use of the telegraph was universally admitted, and it was to its completion that their attention was now needed. The false position in which the old company

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was placed by the late Attorney-General, had nearly destroyed the prospects of telegraphic communication with the East, for perhaps, years to come, but for the earnest and active interference of those who had exerted themselves so effectually to remove the erroneous impression of the insuperable difficulties in the way, and to show that, by the adoption of proper means and precautions, the communication might be restored, while the parties who embarked in the new enterprise were secured the alternative of a very high rate of dividend, if successful, or the reimbursement of their outlay in case of failure. The liberal terms conceded by the Government had effected this, and the argument on which it was based and explained was unanswerable. If the undertaking was successful, the Government would get back their advances; if unsuccessful, they would know that every exertion had been made to secure success, and that after the repayment of their outlay to the shareholders the balance from the sale of the property would go to the Government. The capital of the new company was moderate, £100,000; with one half called up it would be sufficient to restore the communication between Aden and Kurrachee, and thus to bring India within five days of England. The shares were of £2 each. The Limited Liability Act defined and limited individual responsibility of the shareholders. The prospects of success were considered satisfactory by the highest authorities, and the result of success would be to impart a high value to the shares; the result of failure would be to recover the money laid out from the sale of the property of the old company, now made over absolutely to the new company. It was a one-sided speculation with great contingent advantages, and without risk of losing the capital under any circumstances. Two-thirds of the capital required by the Government to be at once raised having been subscribed during the first few days, it was unnecessary to keep open the lists until the decision of the old shareholders was known. Now that it was known no time should be lost in completing the capital, so as to have the shares allotted in the course of the week. He hoped they would all assist the undertaking to the utmost of their power. He and his colleagues and the officers of the company had well supported the measure. The Government had met the question in a fair, liberal, and comprehensive spirit, and the shareholders in the old company having most judiciously accepted the Government proposal as regarded their annuity, had only to give effect to their views by extending their cordial and hearty support to the new company.

Mr. Dent explained that those who wished to take the remaining shares in the new company should apply immediately, and they would get them.

The meeting then separated.

THE FIRST SOCIAL INTRODUCTION OF TELEGRAPHY.

It has generally been received as a fact that the electric telegraph owes its first practical introduction as a medium of communication to its having been the means of the capture of the murderer Tawell, on the 1st January, 1845. We, however, find that its extraordinary capabilities had been ushered into existence under more pleasing auspices, as we find that in the *Times* on the 15th April, 1844, the following interesting announcement was made.

"MESSRS. COOKE AND WHEATSTONE'S ELECTRIC TELEGRAPH ON THE GREAT WESTERN RAILWAY.

"Her Majesty and Prince Albert.—The first intelligence of th arrival of his Royal Highness Prince Albert in this country fron Germany on Thursday last, was communicated to her Majesty a Windsor Castle by means of the Galvanic Telegraph on the Line o the Great Western Railway. Within one minute of the arrival of hi Royal Highness at the Paddington terminus, the information ha reached Slough; at which station a special messenger, mounted upo one of the fleetest horses in the royal stables, was stationed, by com mand of the Queen, and who proceeded with the gratifying intelligenc to the Castle, where he arrived in eight minutes and a half from the time of his leaving Slough. Thus the news of the Prince Consort's return to England reached her Majesty and their Majesties the King and Queen of the Belgians in less than ten minutes after his Royal Highness had arrived at Paddington, and forty minutes before the Prince had reached the Royal residence at Windsor."

Its great practical value was, however, permanently established as a "means of communication between distant places," by the successful transmission of her Majesty's speech in the month of February, 1845, from London to Portsmouth.

THE TELEGRAPHIC SOIREE AT MANCHESTER.

The following materials and manufactures illustrative of ocean telegraphic insulation were exhibited:—

Contributed by the Gutta Percha Company.—Block of raw Gutta percha—Piece of thin sheet, in frame—Piece of fine thin sheet—Case of specimens of ordinary insulated wires—Specimen of Malta and Alexandria core—Specimen of Toulon and Algiers core—Specimen of Atlantic core, recovered from off Newfoundland after two year's submersion—Three specimens of conductors for cables—Specimen of strand; Chatterton's compound on centre wire.

Messrs. Hall & Wells.—Specimens of Submarine Telegraph Cables, made with longitudinal steel wires in combination with Russian hemp, saturated with pitch, tar, and cork-dust—Insulating medium India-rubber—Various specimens of Copper Wire insulated by India-rubber.

Messrs. Silver & Co.—Specimens of Wood and Leaf of Caoutchouc Tree—Ficus Elastica—Ficus Brassii—Natural Sap or Milk of the Caoutchouc Tree—Samples of the following kinds of Caoutchouc:—Para, Gutty, Nigerhead, Root Rubber, Chili, Carthagena, Java, West India, British Guiana—Slab of Masticated India-rubber—Two rolls of Masticated India rubber—Two specimens of Ribbon India rubber, cut from the native bottle—Samples of Wire insulated with native Caoutchouc and Ebonite—Samples of Submarine Cables (Silver's Patent)—Drum covered with Insulated Wire.

Mr. W. H. Preece.—Specimens showing the effect of kinks in Submarine Cable; also the injuries resulting from ships' anchors and abrasion on rocks.

Mr. O. Rowland.—Specimens of all the Cables experimented upon by him under the direction of the Government Committee to inquire into the construction of Submarine Telegraph Cables.

Correspondence.

EXPERIMENTS ON INSULATION FOR STATIC ELECTRICITY.

Sir,—The following tests, which I have lately made, appear to me to possess some interest. I have tested cores of the following construction.

1.—Copper wire, covered with india rubber, and then with gutta percha.
   Insulation not nearly as high as when covered with india rubber alone.
2.—Copper strand, covered with india rubber, then with gutta percha and Godefroy's compound.
   Insulation very low, much lower than if the strand were coated with india rubber alone.
3.—Gibraltar core, covered with a coating of vulcanized india rubber, then with a thick coating of Chatterton's compound.
   Insulation lower than that of a thin coating, say $\frac{1}{32}$-in. of plain gutta percha.
4.—Copper wire, covered with virgin rubber, cotton thread between two coatings.
   Insulation very low.
   The outer coating stripped off, and the cotton removed, the insulation was far superior; although the thickness of the coating had been reduced one half and more.

It therefore appears that a superior insulator, coated over with an inferior one, affords no advantage; and that an inferior [illegible] coated over with a superior one [illegible]

1845.—Well I remember the first auspicious occasion [illegible] tric Telegraph was employed for the transmission to Portsmouth of the Queen's Speech to Lords and Commons in Parliament assembled. It was in February, 1845, when the new means of communication had yet to establish its claims to the appreciation of the public, and when it had as yet been little talked of. Charged with a mission the importance of which, to telegraphy, the public, and ourselves, awakened my utmost energies, I accompanied the *Globe* reporter from the Houses of Parliament to the office of the paper in the Strand. A cab, to which was harnessed the swiftest steed to be found on the rank, awaited us at the door. Mr. Cooke and his staff of telegraphists were in anxious readiness at Portsmouth awaiting the transmission of signals. Rapidly the "copy" was set

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up in type, and the "slip" obtained from which the Speech was to be distributed to all parts of the globe. A moment afterwards I was *en route* with all possible speed for the Nine Elms Station. And then happened our first misadventure, sent by the adverse fates to retard the progress of the greatest invention, and most important mission of modern times. In the Vauxhall Road an enormous van blocked up the passage, and, animated unfortunately by a portion of my own superfluous enthusiasm, against this the cabman came full tilt, depriving his vehicle of one wheel. Comparatively little did we care, however, for injuries done to cab, or van, or to ourselves, providing our legs and the precious proofs in our possession were safe. Leaving the one cab out of its perpendicular in the road, I started at full speed to come up with another. But my troubles were by no means yet ended: a number of street boys, attracted by the crash, and consequent *fracas*, had followed my movements with an interest which was speedily converted into a suspicion of something wrong by the haste exhibited. I heard the cry of "Stop thief!" from a chorus of these *gamins* behind me; but I stopped not until collared by a stalwart working man, conscious of having performed a very meritorious action towards society at large. There was no help but to stand and explain; but never, perhaps, was explanation condensed into so short a space of time,—"Electric Telegraph" and "Queen's Message" were, probably, the only words that struck his ear; but they failed to make any impression on the man's solidity. With dogged tenacity of purpose my captor only shook his head and retained his hold. With a happy instinct of curiosity, a cabman at this moment drove up; and by a desperate effort I got both myself and my persecutor into the vehicle. Reserving to him the right to proceed subsequently to the nearest police station, I directed the cabman to drive in all haste to the railway terminus. Here, of course, everything was explained, and a rough apology tendered and accepted. In other events of a similarly suspicious character the man has doubtless since proved a most valuable member of society. In spite of all *contretemps* my object was accomplished The speech was successfully received at Portsmouth, distributed and printed; an announcement of which appeared in the *Globe* the same evening. Z.

Miscellaneous.

THE completion of the telegraph between New York and San Francisco is regarded with great satisfaction in America, and the first message sent through was one from the mayor of San Francisco to the mayor of New York.

THE Malta and Alexandria submarine telegraph was successfully opened on the 1st inst. During the day, 25 messages of 20 words each were transmitted at the rate of five minutes per message. The length of the line is 1,400 miles.

THE FATHER OF SUBMARINE TELEGRAPHY.—Dr. Hamel, in his interesting account of the "Introduction of the Galvanic and Electro-Magnetic Telegraph into England," claims for his illustrious countryman, the Baron Schilling, of St. Petersburgh, the honour of having, previously to his decease in 1830, contrived a Submarine Cable, which was intended to unite Cronstadt with the capital, through the gulf of Finland.

POWERFUL ELECTRIC COIL.—The Abbé Moigno, the talented editor of the *Paris Cosmos*, states that on the 9th instant he saw M. Rahmkorff, pierce instantaneously, with his induction coil, giving off sparks upwards of seventeen inches in length, a mass of glass nearly two inches thick. This is one of the most astonishing experiments yet performed with that immensely powerful instrument.

A TELEGRAPH PROPHET.—The following is taken from an account of a lecture delivered in London in the early part of 1844. "The lecturer concluded with describing the advantages to be derived from the invention by the Government, the merchant, and even by the lover who at Holyhead ere long would be transmitting his sighs by the lightning, instead of by the gentle zephyrs."

THE PRINCE OF WALES AT THE TEMPLE LIBRARY.—An interesting collection of Telegraphic Apparatus was exhibited at the conversazione, held at the library on the 31st ult., illustrative of the history of Electro-Telegraphy, with which the Royal visitor and his brother Templars were highly pleased and delighted. It is to be hoped that the Great Exhibition of 1862 will have its collection of Telegraphic apparatus from their earliest form to the latest improvement.

TELEGRAPHIC SERVICE IN FRANCE.—In the budget of the Minister of the Interior the telegraphic service, personal and material, figures for 8,587,691f. The personal comprehends 3,441 agents, receiving in salaries 4,793,400f. thus apportioned:—12 inspectors-general, at from 9,000f. to 12,000f. per annum; 56 directors of divisions, at from 5,000f. to 7,000f.; 74 inspectors, at from 3,000f. to 4,000t.; 10 pupils, at from 1,500f. to 2,000f.; 200 directors of sections, at from 2,000f. to 3,000f.; 30 receivers and translators, at from 2,000f. to 3,000f.; 60 transmittors, at from 1,500f. to 2,000f.; 1,260 station-masters, at from 1,200f. to 1,800f.; 91 supernumeraries, at 900f.; 1,200 superintendents, at from 1,000f. to 1,200f.; 507 messengers, at from 500f. to 1,000f.; 1 storekeeper and 25 engineers, at from 1,200f. to 3,000f. Over and above the service rendered to the public departments, the receipts for private telegraphs amount to 5,500,000f. during the financial year.

FREEZING WATER BY MEANS OF HOT AIR.—It has been stated by Professor Holmes, that if a strong current of air artificially dried, and heated to 80°, be passed over the surface of a small quantity of water, the latter will quickly become frozen.

THE ELECTRIC TELEGRAPH BETWEEN PORT ELIZABETH AND GRAHAM'S TOWN, AFRICA.—To come then to the question—Would a telegraph pay between Graham's Town and Port Elizabeth? There does not seem to be the least doubt on the matter. It would certainly pay. The distance is say 80 miles—for the line would avoid as much as possible the main roads, and take the most direct route. To put the line in working order, supply it with instruments, apparatus, offices, stationery, &c., would, according to the evidence given by Mr. Woollaston before the Select Committee on Telegraphs last session, amount to about £50 per mile. That is, for £4,000 we could have a telegraph in working order. Now, considering the commercial relations between these two places—the want of constant information in reference to the arrival, shipping, or despatch, or price of goods, &c. &c.—Government business—the arrival of passengers or their departure—the fact that most persons would, as the large profit man objects, always like to know the price in both places, as well as the merchant, especially in the case of large purchases; and that a great many, too, who could send a message of a dozen words for a shilling, and have their answer back in ten minutes, would prefer this to the delay and trouble of writing. It does not seem beyond the mark to calculate the number of messages at 10s. each way. This, at 3s. per message will bring in a return of £3 per diem, or more than £900 per annum, which, deducting the interest of £4,000 at 6 per cent., would leave nearly £700 for the working and necessary expenses. Now the chief expense would be in replacing the poles; and this, according to the evidence before mentioned, is about 3 per cent. on the original cost, after the first four years. Hence, supposing that the telegraph was worked in connection with the Post-office department in Graham's Town and Port Elizabeth, it is manifest, even allowing the two clerks £100 a-year each, that there would be a considerable balance in favour of the Company or the Government. There is no need at present for an intermediate station; and this being a disadvantage, would be a considerable saving. It appears then that the telegraph proposed will pay—indeed when that already established between East London and King William's Town pays its working expenses—as we are informed it does—it is folly to suppose for a moment that a telegraph from Graham's Town to Port Elizabeth would be a failure. Suppose that a sinking fund were established, we should have, without the loss of a penny to any one, an appliance which is now regarded not only as a comfort, but as an absolute necessity to the wants of all civilized people. It is not likely that in the present political state of the colony, and the purse rather below zero, that Government will undertake a work of this kind. Clerks may be sworn to secrecy; but if intelligence that seriously affects trade passes through the agents of a company, merchants who are not shareholders, will feel, naturally enough, uneasy. The telegraph office would not be sufficiently guarded from intrusion, if several directors had a right to enter it when they thought proper, even though it were only to look after their servant, and see that he was diligent and attentive to his duties: again, the telegraph in the hands of Government is not likely to be made a means of making money, as in the hands of a number of individuals, who are, of course, interested in making it pay. Government would consult the public good, and if the telegraph more than paid its expenses, and the interest of its money, would by lowering the rate of messages, bring it within general reach. Government, too, would have no difficulty in erecting the wires in any direction; whereas the right of private property might be rigorously insisted on when invaded by private individuals, though armed with the sanction of an Act of Parliament. Again, the line would be more secure against mischief in Government hands. On the whole, there can be no doubt, if the Government undertook the work, and that immediately, it would be a great blessing for this province. Perhaps some of our spirited gentlemen will take the matter up, and undertake to advance on Government security the funds necessary for so important a work. All the materials requisite for the line are ready in Port Elizabeth. In three or four months the whole line would be completed, and in our delight in possessing a telegraph, we would only wonder that we had not erected one years ago.—*Eastern Province Magazine.*

To Correspondents.

F. D. G.—A paper upon the subject is being prepared. The description of the battery, the magnet, and instruments, will be given in a simple and comprehensive form by the avoidance of unneccessary technicality or abstruseness.

L. T.—We shall be always ready to insert communications having a tendency to promote useful and scientific enquiry.

Meterological changes, as influenced by electro and magnetic phenomena, offers a wide and interesting field for investigation. Every facility will be afforded to those interested, to discuss the subject in our columns.

We also particularly invite the attention of those electricians who have the opportunity of observing the effect of earth currents, magnetic manifestations, &c., upon the telegraphic lines in their respective districts, and to transmit the same to us for early publication.

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EDGWARE ROAD, 94, Grand Junction-terrace, near Praed-street.
ELEPHANT AND CASTLE, 68, London-road (opposite).
ERNEST STREET, No. 45. ‡Albany-street, Regent's-park.
EUSTON SQUARE, No. 72, corner of Seymour-street.
EYRE ARMS, St. John's-wood.
FINSBURY, *15, Finsbury-place North.
FLEET STREET, 102, office of the "Dial."
GIPSY HILL, †Railway Station.
GOSWELL STREET, ‡159, near Wilderness-row.
GRACECHURCH STREET, No. 24, corner of Lombard-street.
GREENWICH, 1, London-street, corner of Royal-hill, opposite Baths & Wash-houses.
*GRESHAM STREET.
GUILDHALL, Law Courts (during sessions.)
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HAVERSTOCK HILL, opposite Adelaide-road.
HIGHGATE, Post-office, High-street.
HIGHBURY, Post-office, 255, Upper-street, Islington.
HIGH HOLBORN, ‡No. 51; No. 284, (near Great Turnstile.)
HOLLOWAY, UPPER, 5, Hercules-terrace, nearly opposite Tufnell-park-road.
HOUSE OF COMMONS, Central Lobby, (during session.)
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LONDON DOCKS, Principal Entrance.
LOWER NORWOOD, †Railway Station.
MAIDA HILL EAST, No. 6, (Post Office).
MARK LANE, No. 82.
MILE END ROAD, No. 3, (near the Gate).
MILLWALL, *near Pontifex & Wood's Fac.
MINCING LANE, Commercial Sale Rooms, and No. 21.
NEW CROSS, (see Deptford,
NEW OXFORD STREET, No. 455.
NEW WANDSWORTH, †Railway Station.
NOTTING HILL, 24, High-street.
OLD BAILEY, (during Session).
OLD BOND STREET, (see Piccadilly).
OLD JEWRY, corner of Poultry.
OLD KENT ROAD, 1, Watt's-ter., nr. Canal-bridge, ‡4, Friendly-place, opposite Bricklayers' Arms.
OXFORD STREET, 326, corner Regent-cir.
PADDINGTON, Bishop's-rd., op. Royal Oak.
PECKHAM, High-street, near Rye-lane.
PICCADILLY, 43, Regent-circus, *No. 57, corner of Old Bond-street.
PIMLICO, Victoria Terminus, ‡ 78, Gloucester-street.
POPLAR, 134, High-street.
POULTRY, Corner of Old Jewry.
REGENT CIRCUS, 520, Oxford-street, 43, Piccadilly.
REGENT'S PARK, ‡45, Ernest-st. Albany-st.
ROTHERHITHE, Commercial-dock-house, *Entrance to Thames Tunnel.
ROYAL EXCHANGE, Lloyd's.
ST. JOHN'S WOOD, Eyre Arms (adjoining).
SEETHING LANE, Corn Exchange Chamb.
SEYMOUR STREET, corner of Euston-sq.
SHADWELL, *Entrance to Thames Tunnel.
SHEPHERD'S BUSH, near the Gate.
SHOREDITCH, (see De Beauvoir-town.
SLOANE SQUARE, No. 29.
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STEPNEY, Commercial-road, near the Railway-station.
STOCKWELL, 1, Stockwell-place, Clapham-road, opposite the "Swan."
STRAND, 337, opposite Somerset House, Commissionaire Barracks, Exchange Ct.
STREATHAM, †Railway-station.
TAVISTOCK HOTEL, Covent-garden.
THAMES TUNNEL, *both entrances.
THREADNEEDLE STREET, No. 58, Baltic Coffee House, No. 51.
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UPPER HOLLOWAY, (see Holloway).
VAUXHALL, 1 and 2, New Bridge-street, next the arrival platform of South Western Railway.
VICTORIA TERMINUS, Pimlico.
WATERLOO ROAD, 167, nearly opposite the Railway-station.
WEST INDIA ROAD, 4, Wellington-place.
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The Electrician.

Vol. I. No. 2.—November 16, 1861.

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TELEGRAPHIC COMMUNICATION TO AMERICA.

Glancing at the map of the world with a view to telegraphic communication between the two hemispheres, the cosmopolitan philosopher having no very definite ideas of the requirements of ocean telegraphy would naturally look upon the Azores Islands as a very convenient point for halving the distance. It unfortunately happens, however, that these islands are volcanic in their origin, and present traces of recent volcanic disturbance. Hydrographic observation shows also that between the Azores and the coast of North America, the sounding lead finds no bottom at a depth of 3,700 fathoms. The Canaries, the Cape Verde Islands, and the Isle of St. Paul, offer a similar opportunity for dividing the transit. But in this case also, volcanic agencies and the great depth of water, offer almost insuperable objections.

However favourable these routes might have appeared in the absence of due investigation, it is hardly to be expected that they would have been selected by English enterprise for carrying out the object in view. It is not to the problem in the abstract of connecting Europe with America, that we look with the greatest degree of interest. What we require is an English line, touching upon English soil; or one which would be practically equivalent to this. A line which goes anywhere, and ends nowhere, will by no means answer our purpose. But, if it is difficult to calculate the various advantages which would be derived by this country from a direct telegraphic communication with Gibraltar, and from a line to India which would not readily be liable to foreign interference; the commercial benefits which should accrue from the union of British America, and the vast districts peopled by the Anglo-Saxon race, with the mother country, are not easily overrated. To ensure these benefits, a submarine wire from the western shores of Great Britain to her American Colonies, is the most obvious and the only efficient means.

We do not ignore the possibility, or even refuse to recognise the probability, of a communication to America being effected by the eastern route through Asiatic Russia, across Behring Sea somewhat to the south of the Straits of the same name, and thence to Russian America, and further inland to the British possessions. But even were this line completed, as it undoubtedly might be by the co-operation of an Anglo-Canadian Company with the Government of Russia, the expediency of adopting a more direct route would be but little diminished. Putting all national considerations out of the question, it is evident in the first place, from what we know of overland wires, that a line of such enormous length would be liable to contingencies which would render the transmission of messages throughout a matter of frequent impossibility. The sea section, moreover, would be little, if anything, under the distance which separates the coast of Ireland and Newfoundland; and the Aleutic Islands, which have been regarded as stepping stones across the North Pacific, would probably be dangerous resting-places for a submarine cable.

We must not forget to mention the comprehensive project of M. Verrard de Sainte Anne, if it is only to point out its comparative impracticability. This gentleman proposes to commence his line at Paris, conducting it through Belgrade, Constantinople, Teheran, Calcutta, Malacca, Canton, and Pekin, across Behring Straits, then southward through Panama and Lima to Valparaiso, and through Buenos Ayres to end at Rio de Janeiro. To him the difficulties in laying a cable across the Atlantic *plateau*, or by the north western route, would be contemptible indeed.

But, making full allowance for the difficulties inseparable from a scheme of such magnitude, there is little doubt that the confidence of our telegraph engineers in the practicability of an Atlantic route is fully warranted by the great improvement that has taken place in the manufacture of conducting and insulating materials, and the reduction of our previous telegraphic experience to the form of a system. Nor should we undervalue the improved appliances now adopted for testing the various portions of a cable, upon the efficacy and perfection of which so much depends in conducting such enterprises to a successful issue. Many mistakes, such as the employment of a wire of insufficient conducting power can never again occur; for, *inter alia*, the size of a conducting wire necessary for any given length of cable can in future be determined with absolute precision. It is to be hoped also that the expediency of adopting a cable of light specific gravity for deep-sea purposes is now fully recognised.

The route which is marked across the Atlantic as the resting-place of the ill-fated cable which shows what it is possible to effect with more adequate means, has yet many advocates. It possesses the great advantage of touching upon English soil alone. The depths are nowhere very extreme, and the character of the bottom is generally favourable. Nor can the opinion expressed by Col. Shaffner and others relative to the practicability of signalling at a sufficient rate of speed through a conductor of 3,000 miles be now maintained. The question is simply one of the size and quality of the copper wire, and of the amount of the inductive action dependent upon these conditions, and upon the nature and thickness of the insulating medium.

In a subsequent portion of our columns will be found some details relating to the proposed telegraph line, *viâ* the Faröe Isles, Iceland, and Greenland, advocated by Col. Shaffner since the year 1854: the longest section of which would be about 670 miles. According to Sir J. Ross, and indeed in the opinion of most naval men who have considered the question of laying telegraph cables in Arctic latitudes, the most formidable of the difficulties in laying a cable by Iceland and Greenland is due to the various descriptions of moving ice in these regions. On this point, however, a great diversity of opinion exists. On the one side, Mr. Saward, supported by the professional experience of Capt. J. Washington, contends that the danger from floating and grounded ice would render the permanent success of such a line extremely hazardous. Sir J. Ross, while acknowledging the danger from ice, states that *if* 200 *or* 300 *fathoms of water can be obtained to the shore*, the cable will not be liable to disturbance from glaciers, and might be protected from floe ice. On the other hand, Admiral Fitzroy states his opinion that no iceberg could touch the cable when laid in the middle of a fiord; and Capt. Sir E. Belcher remarks that icebergs are so nicely poised that when passing along the bottom, there is little chance of their waking up a cable, as they would roll quietly over, impressing the cable into the ground, instead of damaging it. According to the latter authority, the under portion of a berg is always in a thawing state, with a smooth globular surface; while Sir J. Ross maintains that there are sometimes hooks or prongs to it which scrape along the ground. A line from Scotland to Rockall, and thence, avoiding Iceland, to the coasts of Greenland, is advocated by Sir J. Ross and Admiral Austin, in preference to the route proposed by Col. Shaffner.

There would obviously be little difficulty or expense in settling the question of the possible destructive effects of ice upon the shore ends of cables in the Arctic regions by an experimental test with a short length of cable. There is little doubt, however,

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that the opinions expressed upon this subject by Admiral FITZROY, before the Submarine Telegraph Committee, are substantially correct, and that little danger from ice is to be apprehended, providing suitable precautions be taken.

THE PURIFICATION OF AIR AND WATER.

CIVILIZATION, which supplies us with so many luxuries, unfortunately tends on the other hand to deprive us of the first necessaries of life—pure air and wholesome water. The supply of atmospheric ozone is in cities wholly inadequate to remove the various contaminations of the atmosphere, due to organic decay and other causes which also act prejudicially upon our water supply. Thus a remedy was demanded of Science, which, in our semi-artificial condition of existence, should worthily supplement the great operations of nature it is her privilege to investigate and study. It had long been known that the foulest water, when allowed to filter through a considerable depth of gravel, becomes partly or wholly purified, assuming a limpid and sparkling appearance. The purifying agent in that case is an oxide of iron, which yields up a portion of its oxygen—to the carbon of the *soluble* contaminating matter, to form carbonic acid gas; to the hydrogen to form water; and to the nitrogen to form nitric acid. In many parts of London there are pumps, mostly in the vicinity of ancient cesspools or graveyards, which, from a considerable depth, supply the water which has filtered from the surface soil. This water is both tempting in appearance and agreeable to the taste; but frequently contains soluble organic matter which had *not* been completely mineralized. Since the outbreak of cholera in the year 1854, most of these pumps have been closed by order of the Board of Health.

Air, loaded with the vapours of putrefactive and other hydrocarbons, is to some extent purified by passing through moistened hydrate of peroxide of iron. But a more practicable means of destroying the noxious qualities of impure respirable air is afforded by the element chlorine. This gas readily combines with the hydrogen of the hydrocarbons or of the sulphide of hydrogen; forming muriatic acid gas, and depositing carbon or sulphur.

In the peroxide of iron, the alkaline bi-chromates, and, to a far greater extent, in the manganates and per-manganates, oxygen exists in a condition peculiarly susceptible of combination with the elements of decomposed or decomposing organic matter. These oxygen compounds have therefore been regarded as containing ozone, as their reaction is similar to that possessed by this powerful oxidizing agent.

The alkaline manganates and per-manganates are readily obtained. Four parts by weight of finely powdered binoxide of manganese may be intimately mixed with 3½ parts of the chlorate of potassa, and to this are added 5 parts of hydrate of potassa, dissolved in a very small quantity of water. The pasty mass is then dried, and fused for an hour in an earthern crucible. The resulting compound forms, with water, a red solution, from which fine dark-red crystals of the per-manganate of potassa may be obtained by evaporation. The solution should be filtered through asbestos; as it attacks and oxidizes filtering paper. If the per-manganate be mixed with an excess of caustic potassa, its colour is turned to green; manganate of potassa being formed and oxygen liberated.

The intense red colour of the per-manganate solution is readily destroyed by reducing agents; thus the solution affords a very delicate test for organic impurities either in water or air. The extraordinary energy with which it removes these impurities by oxidation, destroying the active agencies of disease the instant it comes into contact with them, finds a parallel only in the action of the ozoniferous currents of the atmosphere in restoring salubrity after a long period of stagnation and consequent disease. The alkaline effluvia which give their character to the "close" atmosphere of ill-ventilated dwellings, the *miasma* of marshy soils, and the deadly reek of putrifying animal matter have their antidote in this universal purifier. By its action tainted meat, or the foulest water, are speedily deprived of all offensive or poisonous matter. Its effect when used for the skin or for rinsing the mouth in fevers, &c., is equally wonderful. As a gift of science, constituting a safeguard against insidious disease; this most valuable disinfectant is far from being appreciated.

In regard to the purification of *water*, an equally efficacious agent exists in animal charcoal, which, moreover, possesses the advantage of being insoluble in the fluid. Animal charcoal possesses the property—common also to wood charcoal, but to a less extent—of absorbing organic matter from solution; and, in presence of oxygen, of gradually effecting its oxidation or slow combustion. It therefore constitutes a chemical as well as a mechanical filtering medium. Animal charcoal possesses also the valuable property of removing from solution the subsalts of lead which form a frequent impurity of cistern water; and, to a certain extent, it deprives water of the salts of lime which give to it the property of hardness. Thus it is a substance which appears to be specially designed for the purification of our ordinary water supply; and it is to be desired that its employment may become general in the households both of the rich and the poor.

Water in which the salts of lime are present to any considerable extent is generally unsuitable for manufacturing purposes, and is totally unfit for all operations in which soap is employed. Soap, a compound of stearate and oleate of soda, is decomposed by lime; a hard gritty compound of the earth with stearic and oleic acids being formed. This when rubbed into the skin, as commonly happens in the operations of the toilette, is not only productive of a most disagreeable effect, but completely counteracts the purpose for which soap and water are intended. The water is necessarily softened by the action of the soap in producing this insoluble compound; but at a considerable expenditure of material (100 grains of soap for 5 or 6 grains of lime), and when used for the skin, only *subsequently* to ablution! Acting upon the discovery of Dr. CLARKE, that the addition of a solution of hydrate of lime to water precipitates the salts of lime held in solution by carbonic acid, Mr. F. H. DANCHELL has contrived a self-acting apparatus for softening water, which may be fixed in the cistern, and which is charged once a month with a certain quantity of lime. The use of the insoluble compounds of lime with two, three, or four equivalents of oxalic acid, has also recently been proposed for the same purpose.

THE FAILURE OF THE ATLANTIC TELEGRAPH.

THE portion of the Government Telegraph Report, given in our impression of this week, contains an important and interesting summary of the facts relating to the Valentia and Newfoundland cable. The statement in question places in a clear light the causes which not only endangered the success of the undertaking, but rendered its permanent working a matter of impossibility. From our present point of view, the imperfection of the old Atlantic cable, and the mistakes which occurred in connexion with it, are encouraging to future enterprise. They enable us to realize the fact that great progress has been made, and that most of the shortcomings which have occurred, may now be avoided. It would indeed surprise us if, at any future period, a length of 1,250 miles of cable, containing gutta-percha covered wire, were left for months exposed to the direct heat of the summer sun. The account of the ultimate testing of the cable, previous to the first expedition in the year 1858, sounds at the present moment almost ludicrous. "The cable was tested at Keyham, and the leakage reported to be high; but as it was not placed in water for fear of corroding the outer wires, no very accurate data were obtained,"

In the hasty and imperfect investigation which was made to

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determine the form of cable to be adopted for the Atlantic Telegraph, the following conclusions were arrived at:—

1st. That telegraphic signals could be transmitted without difficulty through the required distance;

2d. That a large conducting wire was not required for the purpose; and

3d. That the communication through the conductor could be effected at a throughly satisfactory speed.

The second of these *data*, if not absolutely incorrect, was of dangerous application in the construction of a cable designed to answer a commercial purpose; as the event fully proved. These premises were further extended by a few subsequent experiments; the results of which were stated by the Atlantic Company, as follows:—

1st. That gutta percha covered submarine wires do not transmit as simple insulated conductors, but that they have to be charged as Leyden jars before they can transmit at all.

2d. That consequently such wires transmit with a velocity that is in no way accordant to the movement of the electrical current in an unembarrassed way along the simple conductors.

3d. That magneto-electric currents travel more quickly along such wires than simple voltaic currents.

4th. That magneto-electric currents travel more quickly when in high energy than when in low, although voltaic currents of large intensity do not travel more quickly than voltaic currents of small intensity.

5th. That the velocity of the transmission of signals along insulated submerged wires can be enormously increased, from the rate indeed of one in two seconds to the rate of eight in a single second, by making each alternate signal with a current of different quality, positive following negative, and negative following positive.

6th. That the dimunition of the veloicity of the transmission of a magneto-electric current, in induction-embarrassed coated wires, is not in the inverse ratio of the squares of the distance traversed, but much more nearly in the ratio of simple arithmetical progression.

7th. That several distinct waves of electricity may be travelling along different parts of a long wire simultaneously, and within certain limits, without interference.

8th. That large coated wires used beneath the water or earth are worse conductors, so far as the velocity of transmission is concerned, than small ones, and, therefore, are not so well suited as small ones for the purpose of submarine transmission of telegraphic signals; and

9th. That by the use of comparatively small coated wires, and of electro-magnetic induction coils for the exciting agents, telegraphic signals can be transmitted through two thousand miles with speed amply sufficient for all commercial and economical purposes.

In paragraph No. 8, of the above, the unfortunate conclusion to which we have referred, is repeated in a more objectionable form. It was probably due to the observed fact that with the same *quantity*, or weight, of insulating material, the inductive action increases with the diameter of the wire. As may be seen by the experiments of Professor Wheatstone, as given in his report to the Telegraph Committee; by increasing the diameter of the wire, and the thickness of the insulating covering in the same proportion, the amount of inductive discharge remains the same. But, moreover, it is well established that, with the same thickness (not quantity) of insulating material, great advantage is obtained by increasing the diameter of a conductor in long lines; since the conductivity of the wire is thus increased as the square of its diameter, while the inductive effect increases only as the square root of the same. In point of practice, the advantage is found in the use of a battery of lower tension, and the consequent decrease of retardation in the current.

The failure of August 1857, in laying the cable, is instructive as shewing the necessity of some means for preventing the sudden strain or "jerk" upon the cable in paying out, due to the motion of the vessel in a heavy sea. Although the strength of the cable was calculated to support a weight of four tons, the breakage occurred under a strain of only 35 cwt. as indicated by the dynamometer. The arrangements generally adopted for easing the break in case of sudden strain, appear to be quite inadequate for the purpose of resisting a force which is analogous in its effect to that of concussion. Probably the only efficient mechanical arrangement would be that in which the action of a spring is employed to control the retarding force in paying out. The following is the account given by Sir Charles Bright of the disaster.

The retarding force was, increased at two o'clock to an amount equivalent to thirty cwt., and then again, in consequence of the speed continuing to be more than it would have been prudent to permit, to thirty-five cwt.

By this the rate of the cable was brought to a little short of five knots, at which it continued steadily until 3.45, when it parted; the length paid out at that time being 380 statute miles.

I had up to this time attended personally to the regulation of the brakes; but finding that all was going on well, and it being necessary that I should be temporarily away from the machine, to ascertain the rate of the ship, and to see how the cable was coming out of the hold, and also to visit the electrician's room, the machine was for the moment left in charge of a mechanic, who had been engaged from the first in its construction and fitting, and was acquainted with its operation. I was proceeding toward the fore part of the ship, when I heard the machine stop. I immediately called out to ease the brake, and reverse the engine of the ship; but when I reached the spot the cable was broken.

On examining the machine, which was otherwise in perfect order, I found that the brakes had not been released, and to this, or to the hand-wheel of the brake being turned the wrong way, may be attributed the stoppage, and the consequent fracture of the cable; when the rate of the wheels grew slower, as the ship dropped her stern in the swell, the brake should have been eased. This had been done regularly before, whenever an unusually sudden descent of the ship temporarily withdrew the pressure from the cable in the sea.

ON THERMO-ELECTRIC CURRENTS IN CIRCUITS OF ONE METAL.

[A Paper read at the British Association, Manchester Meeting.]

By Fleeming Jenkin.

In the course of some thermo-electrical experiments, I was led to examine the effect of various distributions of heat in circuits formed by one metal. I verified the conclusion arrived at by Professor Magnus, that no distribution or movement of heat in a continuous and homegeneous piece of metal will produce a current of electricity.

I also repeated, with some variations, the experiments of Seebeck and Magnus, which show that, if one end of a wire be heated, the other remaining cold, a momentary or transient current of electricity will be developed when contact is suddenly made between the hot and cold ends; the direction of the current depending on the metal employed.

I found that I could obtain permanent currents in the same direction from each metal if I simply looped the two ends of the wire together, and heated one of the two loops; and, moreover, that the current was much greater when there was a loose contact between the two wires than when the two loops were tightly drawn together. It is to these currents, due to loose contact between a hot and cold wire of the same metal, that I wish to direct the attention of the Section. I will first shortly describe the apparatus used, and the experiments which showed the existence and importance of these currents, and I will then endeavour to repeat some of the experiments before you. I used a reflecting galvanometer of the form constructed by Professor W. Thomson, of Glasgow. A very light mirror, attached to a very small magnet, hung inside—the galvanometer coil reflects the light of a lamp upon a scale about two feet off. Very small deflections of the magnet are distinctly shown by the movement of the reflected spot of light, while the slight inertia of the moving parts has great advantages when rapidly varying currents are to be observed. A common spirit lamp was used to heat the wires, which were from 0·02 in. to 0·05 in. in diameter.

When two pieces of similar copper wire are connected with a galvanometer, and the end of one wire is heated, a momentary current flows from the hot wire across the joint to the cold one whenever they are suddenly brought in contact. While repeating this experiment, due to Seebeck and Magnus, I found that if the two ends of two such copper wires (being equally oxidised and annealed) were looped together, and held tightly in contact, little or no current could be observed when one of the loops was heated in the flame; but, when the two loops were separated, I observed a momentary current in the same direction as that produced when the hot and cold wire were suddenly joined, *i.e.*, from hot to cold across the joint.

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This fact excited my attention, and led me to consider what the acts of making and breaking contact could possibly have in common. I reflected that, when two wires are approaching or receding, they equally pass through points at every possible distance (within limits) one from the other. Thus I thought that the relative distance between the two wires might be the peculiarity which, being common to the two acts, might produce similar effects in each case. I, therefore, tried the effect of a loose contact between the two wires; resting the one wire very lightly on the other instead of pressing or pulling the two together.

A permanent current was at once produced so strong as to hold the deflecting magnet of the galvanometer against its limiting stops. I then introduced resistance coils into the circuit, for the purpose of reducing the deflection; but, to my surprise, it was not until I had added a resistance equal to that of two thousand miles of the Red Sea cable, or about one thousand miles of the common No. 16 copper, that I reduced the deflections within the range of my galvanometer.

The current could be maintained through this resistance for twenty minutes at a time. Not perfectly constant indeed; but not wavering more than was inevitable from the varying pressure given by the hand to the two wires. The current was strongest when one end of the wire was white hot, the other being dark red.

I varied the experiment in many ways, using different galvanometers and different copper wires, but always with one result. A tight contact gave a barely sensible current; a loose contact gave a current which could be maintained permanently equal to that which would be produced through a similar resistance by the eighth or tenth part of a Daniell's cell; a strength sufficient to signal through a cable to America, if ever one be laid.

I next tried the same experiment with iron wires. Analogous results were obtained, but with one remarkable difference, viz., that the direction of the current was from cold to hot across the joint, instead of from hot to cold, as in copper; moreover, a very sensible current was always observed in iron, even when the two loops were firmly held together: it seems possible that this effect is only a residue of the effect caused by a loose contact, the hard oxide of iron precluding a perfect metallic contact between the loops. The effect is increased at least five-fold when a loose contact is made.

The maximum electro-motive force to be obtained from iron is about one-twentieth that given by copper, and acts in the opposite direction. Platinum gives no current with tight contacts; with loose contacts a weak current flows in the same direction as that given by copper. I must here warn any one disposed to repeat these experiments, that the resistance of the loose contacts is itself considerable, and if the whole circuit, including the galvanometer, be of small resistance, the strongest deflection will be obtained with comparatively tight contacts; for, although the electro-motive force is increased by loosening the contact, the total resistance of the current may be increased in a still higher proportion, and the strength of the current will then diminish. This effect is analogous to the well-known fact in voltaic electricity that, by the addition of small cells in series to a battery with large surfaces, the strength of the current may be reduced if the total resistance of the circuit be small, but will be increased if the total resistance be large. Thus the effects of loose contacts are best seen on a sensitive galvanometer with a large resistance in circuit.

These phenomena may apparently be due to a thermo-electric absorption of heat at the joint, or to a chemical effect on one of the wires, the air or oxide acting as an electrolyte. The opposite direction of the current in iron and copper, however, gives a reason for believing that chemical action is not the cause of the current. The decided effect obtained with platinum is another argument for this belief. It is, moreover, well-established that any variation in the molecular structure of a metal causes one part to become thermo-electrically positive or negative with respect to the other, thus thermo-electric couples can be made of hard and soft wire of one metal, or of crystals arranged axially and equatorially; the current being supported by the Peltier absorption and evolution of heat. Now, discontinuity is the greatest possible change which can occur in the molecular structure, and it, therefore, appears not improbable that the currents due to loose contacts, or, in other words, to discontinuity, may be due to the same cause as the currents due to varying temper, or to crystalline structure; that is to say, to absorption of heat where the change of structure occurs, heat being evolved in other parts of the current at a low temperature. I hope soon to decide this question by further experiments in various media with definite pressures at definite temperatures.

When various metals are combined striking effects are produced, the common thermo-electric current from the joint being often increased fifty or one-hundred-fold; when loose contacts are submitted for tight contacts the direction of the current is also frequently reversed.

The results of these combinations are necessarily complicated, and require further experiment and analysis before publication.

In the ordinary thermo-electric battery, made from pairs of dissimilar metals, a very small proportion of the heat communicated to the joint is converted into electricity, which is, therefore, obtained from them at a great disadvantage. But, considering the comparatively great intensity of the currents produced when loose contacts are adopted, it seems possible that, by their means, a considerable part of the heat used may be absorbed in the production of electricity, which would, in that case, be more cheaply obtained from heat than directly from chemical action.

It is needless to allude to the consequences which would ensue should a cheap source of electricity be discovered; but without anticipating such important consequences from the discovery of the loose contact currents, they certainly seem a fit subject for further investigation, and, meanwhile, it is interesting to consider how, when two wires are tightly joined, the heat given them by the flame travels but a few inches slowly along them, producing all its sensible effects on objects in the immediate neighbourhood, whereas, when these wires are moved asunder to an almost imperceptible distance, that same heat may, in an instant, be flashed as electricity through thousands of miles, re-appearing distributed once more in the form of heat almost simultaneously in every part of the whole circuit.

EARTH CURRENTS.—No. 2.

[Continued from p. 10.]

Having in the last number described the method adopted for determining the various influences which, to a more or less extent, affect the operations of telegraphy, we will now proceed to detail the result of the several experiments.

The two miles of copper wire were insulated upon about 200 porcelain insulators and terminals, and the ends of both wires led into the experiment room. Both miles of wire could be used together or separately, as occasions might require.

In the experiments on insulation for dynamic electricity, the instrument employed was a very delicate galvanometer, having 30,500 coils of copper wire, $\frac{1}{1035}$ of an inch in diameter, covered with silk, and the needle suspended by an unspun silk thread.

The instrument made use of to measure the retention of the charge of static electricity, was a Peltier electrometer, kept in a glass covered zinc box, supplied with chloride of calcium, to avoid humidity.

A Daniell's battery, (Muirhead's improved,) of 512 elements, was employed for charging both with static and dynamic electricity.

The battery was thoroughly insulated by being suspended by straps of gutta percha, made fast to the rafters of the flooring above, and the constancy often ascertained during the experiments by means of a Peltier electrometer. The battery, being always carefully attended to, and thus insulated, maintained a very regular amount of power. The zinc pole was always in contact with copper earth plate during the experiments.

On the 10th of August, 1860, the whole of the insulators were cleanly washed, and then dried with dry towels. After allowing the insulators about an hour to become thoroughly dry, both wires at 11 a.m. were tested for insulation of static electricity, but neither mile sustained the charge an instant.

Wire No. 1 was now tested for the loss of insulation for dynamic electricity. Temperature, 60°.

Time.	No. of Wire.	Loss of Insulation.	State of Weather.
11 a.m.	1	2°	Cloudy
11·25	2	5°	
	2 }	increased in	A slight shower of
	1 }	1 m. to 15°	rain
		4 m. „ 18°	
		5 m. „ 18°	Rain ceased
	Both miles together.	6 m. decreased to 17·7°	Sunshine
		7 m. „ 17·7°	„
		9 m. „ 16°	„
		10 m. „ 14°	„
		11 m. „ 13·5°	„
		12 m. „ 12°	„
		13 m. „ 12°	„
		14 m. „ 12°	„

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The waves of air, as they passed over the insulators, absorbed each its quantum of the moisture, and the passage of these waves or currents of air was beautifully displayed by a corresponding wave-like movement of the indicator, showing the progress of drying, and consequently of improved insulation. A drizzly mist acted upon the insulators, by decreasing the insulation in a similar wave-like manner.

The insulators were again thoroughly wiped with dry towels, and the following tests made :—

Temperature of Experiment-room, 69° ; in the sun, 70°.

Loss of insulation for static electricity on both wires, 50° in 4 minutes.

Loss of insulation on dynamic electricity, *none.*

One insulator being thoroughly wetted within and without, the loss of insulation was 6° ; on Two, 8° ; on Three, 9° ; on Four, 11°.

These four insulators having again been dried, the current was kept on the wires. No loss was observed ; but upon causing a column of smoke to ascend, so as to come in contact with the wires, the needles was instantly deflected, and indicated a leakage or absorption of 4°, with a continuous vibrating motion through an arc of 1·5°.

The smoke having been removed, no loss of insulation was further observable on the dial of the instrument.

Shortly after 3 p.m., dark and heavy clouds passed over the neighbourhood ; the effect upon the needle was peculiar. It was not what might be called exactly "vibration," but an undulatory motion, now slightly to the right, then to the left, &c. Some of the dark clouds appeared as if they attracted the needle upon their approach, and in receding repelled it ; or, in other words, to reduce the tension of the electricity in the wires as they approached, by absorption or otherwise, and as they receded, momentarily to enhance to a small degree that tension.

During thunderstorms and lightning, the motion of the needle when under a full battery charge, and in connection with the insulated wire, was generally tremulous—a tendency to "dip" rather than to deflect angularly ; but on one occasion, during a heavy thunderstorm in the autumn of 1860, the needle suddenly fell to zero, but instantly regained its original position of 32°, which was the loss of insulation indicated at the time on the wire.

During the course of the day several instances occurred, when the needle suddenly deflected 3°, 4°, or 5°, without any apparent cause. Ultimately it was traced to the passage across the wires of the steam from the railway locomotives, which passed within a few yards of the suspended wires. Numerous experiments were subsequently made upon the effects of the currents of steam. It was generally found that when dense columns of steam came in contact with the wires or the insulators a disturbance of the needle took place. The condensation of steam is very slow in some kind of weather, and it has, therefore, a greater effect when it has been carried by the wind against the wires along our telegraph lines. It would be an interesting procedure to determine upon some of our long lines the effect of steam upon their insulation, and how far it may be the cause of the capricious deflections of our signalizing needles which are generally attributed to earth currents, cross contacts, &c. The locomotive at times during its progress is in close proximity to the wires, at other times, the wires are at a distance, and not liable to be affected, especielly when traversing a tunnel, the foot of an embankment, or high elevations, The effect of these irregularities in the relative positions of the locomotive and telegraphic wires, might be determined by the corresponding changes in the insulatory condition of the line upon some fine and dry days, as indicated upon a galvanometer.

When the suspended wires were charged with static electricity, its absorbtion by steam was instantaneous.

When the steam ascended, and circulated amongst the insulators, it not only wetted the surfaces, but condensed in the inverted hollows or bells of the insulators, and, for a time, afforded a ready passage for the fluid to the earth, in the same manner as the morning dew moistened the exterior, and the earth's vapoury exhalations the interior of the inverts or terminals.

What is generally designated a "dry fog," had but little effect upon insulation, but a fog charged with moisture, affected it much in the same manner as the dew and rising vapours of the morning.

Snow deposited upon the surface of the insulator, had not the same effect as ice ; the ice affects the insulation, inasmuch, as it lined the external and internal surfaces of the insulator with a conducting medium, but when the insulators were clean and free from ice, the insulation was found invoriably good in frosty weather.

It should, however, be observed here, that in all the above experiments, one end of the wire was always insulated, that is, not in contact with earth, and that the other end, in testing with *dynamic* electricity, was in contact with the copper pole of the battery.

In a future number an account will be given of what are generally known as earth currents, as they manifested themselves, under experiment, upon the same wires.

(To be continued.)

MALTA AND ALEXANDRIA TELEGRAPH.

[From the Morning Post.]

The unpleasant task of recording failures in the greater enterprises of submarine telegraphy has been so frequently imposed uon us, that it is with more than ordinary pleasure we notice the fact, that a cable extending more than fourteen hundred miles has not only been laid along the bottom of the Mediterranean, but is now placed in a state of perfect efficiency at the service of the public. The telegraphic cable which was laid down about a month since between Malta and Alexandria, has during that period been submitted to a series of experiments, all of which having proved eminently satisfactory, the Government have taken it off the contractor's hands ; and it being now at the disposal of the public, its services may be as confidently relied upon as those of the shorter cables which connect England with Ireland or with the Continent. There is no scientific reason why a wire of any imaginable length should not serve for the conveyance of messages between two points however remote from each other. An electric current of any degree of strength may be generated ; and, assuming a cable to encircle the globe, it would be in the power of scientific men to construct an apparatus capable of transmitting an electric stream over a distance of twenty-four thousand miles. But although there may be no reason in a scientific point of view why the length of an electric cable should be limited, there are thousands of reasons why practically we must content ourselves with certain definite lengths. In no mechanical combination does the maxim that "nothing is stronger than its weakest part," obtain with greater truth than in respect to an electric cable. Let one point be weak, a single hair's-breadth be defective, and the miles of intact wire on either side of the flaw become perfectly useless. The immense mass of cable which cost so much in its construction, and such infinite trouble and danger in its consignment in safety to the bottom of the Atlantic, is in all probability as perfect and uninjured, save at a single point, as when it was coiled in the holds of the vessels which conveyed it to its destination. Yet it lies there hopelessly abandoned, and the efforts made to recover it succeeded in regaining but a few miles at each extremity. The laying of a submarine telegraph is purely a commercial enterprise, and, consequently, must be submitted especially to one test, namely, the probability of its proving eventually profitable. Regarded from this point of view, there are two conditions which must govern all enterprises in the field of submarine telegraphy. First, the distance between the points connected must be so short as to admit of the cable being laid with comparative ease and safety, and being with equal facility repaired if necessary. And, secondly, where the distance between the extreme points is so great as to render a considerable length of cable necessary, it should, though at the cost of much additionable cable, be laid so as to be with ease recovered in case of accident and repaired. The Atlantic Telegraph Company carried their cable over the course a bird would fly between Ireland and Newfoundland, namely, between the nearest points. The extreme difficulty encountered in laying down the cable must have warned them that when once laid no means could be devised for recovering it from the depths of the ocean. And so it has proved. In the present instance the contractors, wise in their generation, instead of carrying the cable by the nearest route between Malta and Alexandria, and thus abandon the certainty of recovering it from the bottom of the Mediterranean, should it prove necessary to do so, laid the cable over the comparatively short intervening space between Malta and the African coast, and then carried it at some little distance from the latter in shallow water to its destinatron.

We hail with satisfaction the success of the Malta and Alexandria telegraph, not only on account of the special advantages which it affords, but as giving a guarantee of the practicability of establishing telegraphic communication between nearly every portion of the habitable globe. An unbroken cable of one thousand four hundred miles in daily use is now an accomplished fact. A brief glance at a map of the world will satisfy an observer that, by means of cables not exceeding that in length, telegraphic communication may be established between the four quarters of the globe. Europe and Asia are adjacent, but the former continent is now connected with one of the most important ports on the African coast by the cable which has just been laid, taken in conjunction with its northern continuation to

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Sicily and the south of Italy. Between the British Isles and North America communication may be established by laying three cables, none of which equal in length two-thirds of the cable which now unites Malta with Alexandria. Greater difficulties may possibly oppose themselves in consigning to a safe resting place at the bottom of the North Atlantic Ocean a thousand miles of wire, than in the comparatively placid waters of the Mediterranean Sea; but they are not difficulties which are insurmountable. In carrying a telegraphic cable from Scotland by the Faroe Islands to Iceland, and thence to Greenland, and thence to Newfoundland, the chief obstacle, in a commercial point of view, will be the loss incurred in case of a mishap. Between these points the cable, when once laid, must be regarded as laid for ever. The notion that a submarine cable once laid with safety would never need repair has long since exploded. So well aware are the contractors, to whom we understand the Government have let for a term of years the Malta and Alexandria cable, of the necessity of keeping it in constant repair, that a small steamer will be kept continually employed to recover and repair it at any places it may prove defective. The impossibility of repairing, if needful, an Atlantic telegraph, however laid, must always prove the greatest obstacle to the successful issue of an undertaking having for its object the establishment of telegraphic communication between Europe and America. Still, however, with the spectacle of a cable upwards of a thousand miles in length, in good working order, before their eyes, we are much mistaken in the enterprise and perseverance of British capitalists if a second attempt is not shortly made to bridge over in some way or another the vast expanse of the Atlantic Ocean.

Whilst it is impossible to magnify the advantages afforded by the telegraph now extended across the Mediterranean, one cannot help regretting the failure of the attempt to construct its proper complement, viz., the cable from Suez to Aden, and thence to India. The opportunity now presented for the transmission, in a few hours, of messages from Egypt to England, will enable us to receive intelligence from our Eastern empire in one-third of the time hitherto required. But even with this we cannot remain satisfied. However great may be the difficulties in the way of carrying a cable in safety from Aden across the Indian Ocean, those opposed to the establishment of telegraphic communication between that port and Suez cannot be regarded as insurmountable. We are aware that though it would be comparitively easy to construct aërial lines along either shore of the Red Sea, yet they would be constantly exposed to danger from the nomad tribes which infest the adjacent country. It may have been wise on this account to abandon this plan, but the only ground on which its abandonment can be justified is the conviction of being able to lay down a submarine cable. To effect such an object can no longer be regarded as impractible since the successful issue of the undertaking under notice. It surely must be as easy to carry a cable along the shores of the Red Sea as along those of the Mediterranean. At all events if the ill success which attended one attempt should attend a future one, it might be worth while to consider whether it would not be advisable to construct aërial lines on the coast, and keep a steamer constantly employed to repair them when damaged. This of course might prove a service of considerable danger, but still this plan should be adopted in preference to the abandonment of the entire scheme. We entertain no doubt, however, that the next attempt to lay a Red Sea telegraph will prove successful, and that many years will not elapse before the much needed ocean telegraphs will serve the purposes of mankind with the same fidelity as that which now winds its devious path along the bottom of the Mediterranean.

RED SEA AND INDIA TELEGRAPH COMPANY.

The directors of the Red Sea and India Telegraph Company have announced that the Government have accepted the resolutions passed at the general meeting on the 5th instant, subject to the fulfilment by the new company of the preliminary conditions required by Government. A statement has been issued, comprising a copy of the correspondence which has taken place on the subject; and the two following letters, completing the negotiations, are of importance to those interested in the projected telegraph to India:—

From the Board to the Treasury, Nov. 13.

"The Red Sea and India Telegraph Company,
"No. 62, Moorgate Street, London, E.C., Nov. 13.

"Sir,—I have the honour to acknowledge the receipt of your letter of the 12th instant, and am instructed to state in reply that, assuming the conditions you refer to in your letter, as affecting the new company, viz.: 'That the new company shall have so far fulfilled the conditions of its agreement as to have entitled it to the contingent return of 25 per cent. on their capital,' to mean, as stated in your letter to the directors of the new company of the 19th October, 'that the company shall be formed with a capital of £100,000, with power to increase to £250,000, of which two-thirds shall be subscribed, and one-third paid up, and a suitable vessel despatched with not less than 200 miles of new cable on board,' the directors of this company will be prepared to enter into an agreement with the Lords Commissioners of Her Majesty's Treasury (subject to ratification by an Act of Parliament, to be introduced by the Government) for carrying out this arrangement, which the directors believe to be in accordance with the intention of the proprietors at the last general meeting.—I have the honour to be, &c., "C. L. Peel, Secretary.

"The Secretary to the Treasury, &c."

From the Treasury to the Board, November 13th.

"Treasury Chambers, Nov. 13th, 1861.

"Gentlemen,—In reply to your secretary's letter of the 13th instant. I am commanded by the Lords Commissioners of Her Majesty's Treasury to acquaint you that you have correctly interpreted the meaning of the paragraph referred to therein, as contained in the letter of this board dated 12th instant.—I am, &c., "Geo. A. Hamilton.

"The Directors of the Red Sea and India Telegraph Company."

General Financial Retrospect.

Friday Morning.

Financially the appearance of the future is more encouraging, though this may seem in a degree paradoxical, when the state of business in France is considered, and the dulness pervading our own markets is adequately recognised. Nevertheless the truth of the position assumed can be proved, and hopes are entertained that, with the exercise of caution, a French financial crisis may yet be avoided. It, however, required a strong arm to interpose between the Emperor and his expenditure, and it was evidently up to a very recent date doubtful if any one would have sufficient courage to attempt to deal with the emergency. M. Fould has stepped in at the opportune moment, and boldly facing the difficulty, has presented Louis Napoleon such a programme, that while it will at least avert much mischief, cannot fail to render his imperial master sensible of the danger into which he has brought that country, and of the necessity of retrenching with all possible expedition. Although M. Fould is not universally popular, especially in England, his views of policy will be supported, and as the Emperor professes willingness to pursue the course indicated, the issue of his endeavours will be awaited with anxiety. A loan and other pecuniary expedients will naturally be the consequence, but these matters our Parisian neighbours will have to deal with, and will meet them in the best way they can. If M. Fould perseveres in sustaining his own power, and there is a strong impression that he will, much of the unsettled feeling with regard to Italian hostilities, and a revival of the wars of nationalities will be for the present altogether dissipated. Should American affairs show any symptoms of amendment, the influence would soon be general and extensive.

The Bank of England still charge 3 per cent. as the minimum terms of accommodation. The accounts published last night show that they are not in a position to go lower, and consequently the rates out of doors are again hardening. The brokers are nevertheless certain, unless a very active demand arise to keep the quotation a quarter below the official price, in order to secure the larger portion of the business. As it appears probable the situation of affairs in France will not experience great amelioration immediately, the Directors of the Bank of France have refrained from lowering the rate. Towards the end of the year the value of money usually increases, and this will again be the case in the course of the next two or three weeks.

The creditors of Messrs. Bernardi, Rosenthall, and Co., meet to-day, to receive a statement of their affairs. It is not supposed that it will be satisfactory, though the debts and liabilities reach from £50,000 to £60,000. Messrs. Amott, Brothers, the large drapers and goods salesmen, of St. Paul's Churchyard, have stopped, with engagements for about £30,000. Under this estate it is also feared there will be a large depreciation in the assets.

Owing to the state of incertitude in which things were at the

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commencement of the week, little disposition was manifested to operate in the funds. The reports of M. Fould's accession to office on the other side of the channel, and the known vigour of his measures if he did accept place, gave strength to prices, though there was no particular buoyancy. On Wednesday it was doubtful if the Emperor would submit, and consequently a lull ensued, leaving the market in a depressed situation. Yesterday when the official text of the arrangement appeared in the *Moniteur*, all this heaviness was removed, increased animation became apparent, and quotations improved about one half per cent. Consols then at the last moment were marked 93⅞ to 94 with dividend for money, and 92⅝ ex-dividend for the account. Surplus balances having found their way into Exchequer Bills, the quotation has risen to 16s. to 20s. India 5 per cents. having been purchased at 107, have gone back to 106½ to ¾; the Board of the East India Railway Company having issued the balance of their capital, £1,600,000 *pro-rata*, at par among the proprietors. Thus an increase in the supply of a 5 per cent. dividend security has been brought into competition with that already in the market, bearing, although under slightly different circumstances, a high premium.

Although the half-monthly settlement is being adjusted in foreign securities, some appetite exists for operating by the operators. Spanish certificates continue to be taken freely up to 7, a further advance on last week, because it is said the authorities at Madrid propose eventually to provide in some shape for these claims. Mexican, as a cheap stock with favourable prospects, has once more advanced from 23 to 28 in the short period of two or three months—a very good rise. Turkish is the next most active security, the original six per cents. being quoted 80½ to ¾, and the new six per cents. 69½ to ¾. Venezuela is better; Buenos Ayres, on the other hand, has slightly dropped.

The account in railway shares has gone off in a satisfactory manner, a rather more plentiful supply having been furnished of the principal speculative description; a partial weakness has been exhibited, but still, on the whole, the market seems to be considered in a favourable condition. The traffic, on an average, keeps up well for the season of the year, which is rather surprising, looking at the late doubtful state of trade, and the not very strong expectations of improvement. The long summer and the fine autumn have prevented the full development of the paralysis in the manufacturing districts. Other miscellaneous securities, including Joint Stock Bank shares, are pretty firm; the abundance of money, with the desire to hold steady dividend investments, arresting the efflux of capital into other channels.

Arrangements have at length been completed between the Red Sea and India Telegraph Company and the Government, the latter accepting the resolutions passed at the late meeting. The Telegraph to India Company will now be launched with every hope of a prosperous issue, and the original proprietors of the Red Sea are to participate in the allotment of shares.

PRICES CURRENT OF INSULATING MATERIALS.

The markets both for Gutta-percha and India-rubber have within 14 days been on the advance.

Fine Gutta, several parcels have been taken off the market from 2d. to 3d. per pound advance.

	s.	d.
Fine may now be quoted	1	6
Good and Middling	1	3
Ordinary	0	7

India-rubber, several orders have been executed both for Russia and America, which has made the article very firm, and the quotation may now be

	s.	d.
Fine Para	1	8
Good and Mixed	1	3
Negro	0	11
East India, Java, and Penang	1	3

November 15, 1861. W. KIRKMAN.

EXPERIMENTS ILLUSTRATIVE OF THE DURATION OF THE RETENTION OF A CHARGE OF STATIC ELECTRICITY COMMUNICATED TO A PELTIER ELECTROMETER, FROM A DANIELL SULPHATE BATTERY OF 512 ELEMENTS.

The instrument was kept in a zinc box supplied with chloride of calcium for the absorption of humidity, the box covered with a glass lid. The instrument being charged each time to full tension of battery, namely 50°; the time occupied by the needle in falling 8° was carefully noted. The experiments are submitted with a view to invite the attention of those interested in the science of electricity as bearing upon meteorological changes. The experiments extended for a period of six weeks, and at the end of the month the loss of charge did not exceed 1° in fifteen minutes.

Date.	Hour.	Temperature Outside.	Weather.	Loss of Charge.
				° ′ ″
June 4, 1860,	11· 0 a.m.	57·5	Fine	8 in 6 0
	11· 7 a.m.	57·5		8 in 7 15
	11·18 a.m.	57·5	Sunshine	8 in 10 15
	11·29 a.m.	57·5		8 in 10 45
	11·35 a.m.	57·5		8 in 6 45
	11·42 a.m.	57·5		8 in 3 0
	12 a.m.	54	Rain	8 in 2 0
	12·30 a.m.	54		8 in 4 15
	1 p.m.	54		8 in 6 0
	,,	54	Gloomy	8 in 3 0
		54	Sunshine	8 in 4 0
	1·20 p.m.	54	do.	8 in 7 15
	1·28 p.m.	54	do.	8 in 6 0
	1·35 p.m.	54	Gloomy	8 in 5 0
	,,	54	Rain	8 in 4 0
	,,	54	do.	8 in 3 30
	2 p.m.	54	No rain	8 in 3 30
		54	do.	8 in 3 0
		54	do.	8 in 1 0
		54	do.	8 in 1 0
		54	do.	8 in 1 30
		54	do.	8 in 1 30
		54	Sunshine	8 in 2 0
		54	do.	8 in 4 0
		54	do.	8 in 4 0
		54	Rain	8 in 3 30
		55	Sunshine	8 in 4 0
		55	do.	8 in 4 0
		55	do.	8 in 4 0
		55	Rain	8 in 3 0
		55	do.	8 in 3 0
	2·46 p.m.	56	do.	8 in 3 0
	4 p.m.	56	do.	8 in 4 0
		56	do.	8 in 2 0
	4·20 p.m.	56	do.	8 in 3 0
		57	Cloudy	8 in 4 0
	to	57	do.	8 in 5 30
		57	do.	8 in 6 0
		57	do.	8 in 6 0
	4·55 p.m.	57	do.	8 in 6 0
	5· 2 p.m.	57	do.	8 in 6 0
	7·15 p.m.	55	Rain	8 in 5 0
		55	do.	8 in 4 15
		55	do.	8 in 6 0
		55	do.	8 in 2 0
	to	55	do.	8 in 2 15
		55	do.	8 in 4 30
		55	do.	8 in 3 45
		54	do.	8 in 5 0
	8 p.m.	54	do.	8 in 5 0
		54	do.	8 in 5 0
		54	do.	8 in 5 0
		54	do.	8 in 5 0
	to	53·7	do.	8 in 3 0
		53·7	do.	8 in 3 0
		53·7	do.	8 in 3 0
		53·7	do.	No loss in 5 0
		53·7	do.	do. 10 0
	8·45 p.m.	53·7	do.	8 in 2 0
		53·7	do.	8 in 2 0
	10 p.m.	53·7	do.	No loss in 5 0
	11 p.m.	49·5	do.	do. 5 0

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NORTH ATLANTIC TELEGRAPH ROUTE.

Sea Sections.

The distinctive features of the North Atlantic route are, its subdivision into four short sections, the respective lengths of which are as follows:—

I.	Scotland to the Faröe Isles	225 miles.
II.	Faröes to Iceland...	240 „
III.	Iceland to Greenland	670 „
IV.	Greenland to Labrador	510 „
	Total, proximate submarine sections ...	1645 miles.

The cable will be in distinct lengths for each of these sections so that should any derangement occur in one length of cable the whole property will not be imperilled; and should cables be laid in duplicate, as they probably may be, and hereafter in triplicate, an uninterrupted through communication may at all times be insured, even during the repairs, should they be required, of one or more sections. The shortness of the lengths will make the laying of cables in duplicate a matter worthy of consideration as the undertaking proceeds.

The promoters of the North Atlantic Telegraph Scheme were encouraged by the surveys of 1859, and the opinions of many distinguished navigators, to enter vigorously into the undertaking, and to take all proper measures to have a full and faithful survey made of the ocean route, and the coasts and bays; to visit and examine minutely every spot, and to select routes and landing-places. In prosecuting their plans they have been sorely tried by the severity, almost without a parallel, of the weather, which has marked in so peculiar a manner the year 1860. Inclement and ungenial it has been in England; tempestuous beyond measure was it in the northern seas! Besides this, the coasts of Greenland were beset with ice in a remarkable and exceptional manner. "Several intelligent Danish inhabitants of the colonies informed me," writes Mr. J. W. Tayler, "that more than thirty years had elapsed since there had been so much ice seen there and remaining so long." Add to this the opinions of the residents of Greenland appended to this pamphlet, and the difficulties experienced by the telegraph expeditions of 1860 can be appreciated, as the most extraordinary ever known to occur upon the Greenland coasts. The surveying parties executed almost to the full their commission; and have rendered a most satisfactory account of their mission. They saw no obstacle of an uncommon character. They discovered nothing to affect the opinions that were given before their work was begun; on the contrary, they came home fully satisfied that with ordinary prudence the undertaking might be brought to a successful issue.

Captain Allen Young reported from the Faröe Isles:—"I find Thorshaven perfectly adapted for the reception of a cable; but as it would be liable to damage from anchors, I have selected an excellent little bay called Sandyyerde . . a cable might be landed, and lie in perfect repose on a sandy bottom and sandy beach, and perfectly land-locked." Then as to the other side of the Faröes; "At Haldervig we surveyed harbour and fiord, and found all satisfactory; and I think that place to be well adapted for the reception of the cable. We found but little current, and the cable can be taken in, in a tolerable depth of water, into a perfectly land-locked position." Then as to the practicability of landing on the east coast of Iceland: "We surveyed Berufiord, anchorage and bays, as far up as Guetavig, on the north shore, where I shall propose to land the cable. There will be no difficulties from sea-ice or otherwise." In a letter, dated a few days later, he said: "Since writing to you on the 26th inst., I have examined Hvalfiord, near Reikiavik, west coast of Iceland, and Mariahaven; and find it well adapted for landing the cable; ..... the end of the cable can be taken on shore in Mariahaven, nine miles from entrance to fiord, on to a sandy beach, and where it will lie at repose and in a land-locked position."

The practicability of Portland on the south of Iceland is referred to in the report of Dr. Rae, viz.: "By information received from some of the most intelligent and respectable gentlemen at Reikiavik, I am led to believe that Portland, on the south coast of Iceland, although not a harbour for vessels, is well fitted for the landing of a cable."

With respect to landing at Greenland, Captain Young reports: "Returning with the Fox to Julianshaab, Oct. 27th, we then surveyed the estuary of the fiord; and from the soundings obtained, I am of a decided opinion that a *depth of not less than* 150 *to* 160 *fathoms* can be carried from the middle of the fiord, abreast the settlement, out to sea, with a general muddy bottom. *This depth of water will effectually preclude injury to the cable from the largest icebergs ever seen upon the coast.* Although many bergs lay along the coast, we saw none aground in this valley of the fiord; nor, according to information obtained from the residents, have they been seen grounded in that channel." He further adds: "My decided opinion is favourable to the practicability of the undertaking; and that Julianshaab will, under all circumstances, be well adapted for the reception of the cable..... The ice *usually* dispersing from the south-east shores of Greenland in the autumnal months, opportunities will always occur when a ship, having the cable on board and lying in readiness in Julianshaab, may depend upon having a period of clear and open sea. *The cable once laid no drift ice can in any way injure it, if the proper precautions are taken in securing the shore end.*"

We have still stronger encouragement at the hands of a gentleman, Mr. Tayler, a Fellow of the Geological Society, who has for seven years past actually resided in Greenland, and within the very district which had been considered by the promoters as most suited for landing the cable. He, of all men, is most qualified to give an opinion; because he can speak of the climate and the habits of the ice from an experience not of days or weeks, or even months, but of years. We have already given his evidence as to the anomalous character of the past season. He says, "I know that places do exist in Greenland at which the cable can be brought to land from depths of water so great, as to preclude the possibility of icebergs grounding upon it. Such places may be found between lat. 60° N. and 60° 20′; for example, Tessermiut Fiord, the large island of Sermisok, remarkable for the perpendicular cliffs at its southern extremity; and several other places, where the rocks are nearly perpendicular, and frequented by the birds in the breeding season." Further on he goes to say, "The icebergs, therefore, which are formed in the fiords of S.W. Greenland do not ground, except in the shallower parts of the fiords; and in the deeper parts there is no possibility of icebergs grounding in the depth of water, in which the cable would be laid." Then again, in regard to certain suggestions as to masses of stone likely to be liberated on the dissolution of icebergs:—"In the first place," he says, "not one berg in a thousand is seen to contain boulders; in the second place, the temperature of the water is so near the freezing point, that but little of the bergs are melted on their passage round South Greenland; and, in the third place, should such a thing occur, and a large boulder sink and fall upon the wire, I do not imagine that it would produce the least ill effect, since its specific gravity is but about 2·5, &c." As to the accessibility of the coast in respect to the ice, he adds: "The middle of September, when the ice gradually diminishes, until in the month of October the sea becomes free from ice, so much so, that but one or two straggling bergs can be seen from the highest mountains, &c..... It is, however, unnecessary to fear any impediments as regards the ice to laying the cable; for the reason that the cable would not be laid to Greenland; but, on the contrary, would be taken from thence to Iceland, round Cape Farewell on the one side, and to Labrador on the other." "I admit," he says, further on, "that vast quantities of ice are to be met with on the coast of Greenland; but there is also a time when the sea is perfectly free from ice. I admit that icebergs draw much water, but I know that the water is very much deeper, and that they cannot ground in the track of the cable."

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Of like import is the evidence of Captain Sir Leopold M'Clintock. "South Greenland," he says, "is usually enveloped with drift-ice and icebergs, whilst in the autumn it is for the most part free. It is, however, liable to be more or less obstructed throughout the whole year; the present, for instance, has been an extremely bad one, probably the worst for thirty years: and yet the Bull-dog (paddle-steamer), the Fox (screw), and the Danish sailing vessels, have visited Julianshaab in September, October, and November. My humble opinion is, that in two years out of every three, the ice will be too inconsiderable to obstruct the laying down of a cable during the autumnal months."

The season of 1860 was so unusually severe, that the survey of the landing place on the Labrador coast was only partially accomplished. "Hamilton Inlet was rapidly explored," as remarked by Capt. Sir L. M'Clintock; "the main channel, for about half its entire length, sounded, and the whole laid down by Mr. Reed with sufficient accuracy for ordinary purposes; but these soundings are not nearly sufficient for the requirements of a cable." This inlet is 118 miles in length; and is very wide where it enters the sea; so that there is a large area to explore, and a wide field from which to select a route; and there is no reason to fear the result. On this point Sir L. M'Clintock remarks:—"A perfect survey is requisite, and may show that the shoal water and reefs of rocks, which appear so intricate to us at present, can be avoided. I was told that the deepest channel lay to the north of George's Island, and between it and the Hern Islands. This is also the widest channel, measuring not less than five miles. It is reported that large icebergs rarely drift into the mouth of the inlet, and only during easterly gales of long continuance; and that no icebergs ever come inside the Hern Islands."

Captain Sherard Osborn, who is a good authority on Arctic questions, before the sailing of the expeditions of 1860, stated:—"In a nautical and physical point of view, I know of no reasons why a cable should not connect the Canadas or Labrador with England. I am fully aware that ice streams down the coast of Greenland and Iceland; but I do not see in what way that will affect a small cable lying upon the bottom of the sea. . . . When it [floe ice] moves about it is afloat; and when afloat, there is always water enough beneath it to allow a cable of half-an-inch or more in diameter to lie undisturbed on the bottom of the sea. . . . A floating iceberg can never hurt a submerged cable, and even one grating or pressing along the bottom may, nine cases out of ten, fail to pick up a piece of rope embedded in the mud or sand; indeed, the probabilities are, the cable would be only thrust still deeper into the bottom. Icebergs have not got claws or creepers; and I believe the cables across the narrow seas between England and Europe run fifty times more risk from the thousands of anchors, creepers, and trawling-nets ever passing over them, than any cable would do under the Atlantic between Hamilton Inlet and Greenland."

Reports on the Land Sections.

With regard to the overland routes in the Faröes and in Iceland, there appear to be no difficulties. Dr. Rae says:—"Having carefully examined the route, which was found perfectly practicable for the passage of a telegraph wire," "from Thorshaven to Haldervig, a distance, by the route we followed, of about 27 miles." And of Iceland he says:—"We took our departure from Berufiord, and after a journey of fourteen days' duration, having travelled 450 statute miles, reached this place (Reikiavik). The road, although not good, is such as a telegraph wire may be passed over and kept in order." "Although we by no means followed the shortest route, or that best adapted for telegraphic purposes, no obstacles, as far as I could notice, presented themselves to the erection of a telegraph wire." Lieut. Von Zeilau, and Mr. Olafsson, the Danish commissioners, concur in Dr. Rae's opinion, and say:—"A line can be constructed across Iceland with all reasonable prospects of permanency." Sir L. M'Clintock writes:—"I trust you will adhere to the original intention of a land line across Iceland to Faxe Bay, as by so doing you will avoid the only part of the sea where submarine volcanic disturbance may be suspected. Faxe Bay never freezes over, and I find no record of drift-ice within it since 1683. Merchant-vessels come and go throughout the winter."

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 7.]

Deep Sea Cables.

We now pass to Deep Sea Lines, and amongst the first, notice the Atlantic Telegraph.

In 1851, Mr. Tibbett, of New York, and Mr. Frederick N. Gisborne, an English engineer, proposed to shorten the communication between America and Europe, by making St. John's, Newfoundland, a port of call for Atlantic steamers, and constructing a telegraph from thence to join the American lines. In 1851, they obtained an Act of the Legislature of Newfoundland, which gave them the necessary powers, and also conferred upon them certain exclusive privileges. These gentlemen were, however, unable to fulfil the terms of the Act, and they transferred their interest to a new Company, chiefly promoted by Mr. Cyrus Field, Mr. Dudley Field, Mr. Peter Cooper, Mr. Chandler White, Mr. Moses Taylor, and Mr. Marshall O. Roberts, and called the New York, Newfoundland, and London Telegraph Company.

This Company obtained an Act of Incorporation in 1854, which conferred, amongst other privileges, the exclusive right of landing cables on the coasts of Newfoundland, or on the islands or places within the jurisdiction of the Government of Newfoundland, for 50 years, and no limit was assigned to the time which they were to exercise this right. In 1856 Mr. Cyrus Field, Sir Charles Bright, Mr. Brett, and Mr. Whitehouse, entered into an arrangement with the New York, Newfoundland, and London Telegraph Company, by which the privilege of laying a submarine line between Europe and the coasts of Newfoundland and Labrador was transferred to them; but these privileges were to revert to the New York, Newfoundland, and London Telegraph Company, if not exercised before 1862. These gentlemen formed the Atlantic Telegraph Company, and obtained a grant of £14,000 per annum from the British Government, to be paid when and so long as the line was in working order, and the American Government gave a similar guarantee. Upon this, the Provisional Directors of the Company raised £350,000 in shares of £1,000 each, and they undertook that the line should be laid in 1857. It was not until after this had been done that the permanent Board of Management was formed.

Some experiments upon forms of cable best suited to the purpose were made at Messrs. Glass and Elliot's works. The form selected was calculated to bear three tons. It consisted of a strand of seven copper wires, each No. 22½ gauge, weighing 93 pounds per mile, covered with three coats of gutta percha, weighing 227 pounds per mile, served with thread jute yarn, saturated with a composition of tar and other materials, and coated with 18 strands of iron wire, each strand containing seven wires, each of No. 22 gauge; but it is to be regretted that there was no such thorough preliminary investigation as the importance of the subject demanded, because the undertaking given that it should be laid in 1857 did not afford the time necessary for such an inquiry. Mr. Whitehouse (Question 1838) states that Mr. Cyrus Field objected to further experiments, because it would have put off the laying of the cable for twelve months; and other persons admit that additional experiments should have been made.

Messrs. Newall contracted for the manufacture of one-half of the cable; Messrs. Glass, Elliot, and Co., contracted for the other half; and the manufacture was commenced in February, 1857. Messrs. Glass, Elliot, and Co. had no covered works in which to stow it, and the summer being very hot, the cable was partially injured by the sun. A considerable variation in the conductivity of the copper wire was observed during the process of testing, and a standard for the conductivity of the copper was consequently adopted, but not till nearly the whole of the cable had been manufactured. The cable, 2,500 miles long, was finished in July, 1857.

The United States steam-ship, "Niagara," said to be a vessel of 5,000 tons, received the portion manufactured by Messrs. Newall, and Her Majesty's ship "Agamemnon," a vessel of 3,200 tons, received the portion made by Messrs. Glass and Elliot. The apparatus for the laying of the cable was scarcely complete when the ships arrived at Valentia. In the first expedition it was settled that the ships should proceed together from Valentia to Newfoundland, and as soon as one ship had paid out the cable on board, a joint was to be made with the

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portion on board the other ship; many objections were raised to this course, because it was evident that if the weather should happen to be bad when the joint was to be made, half the cable would be inevitably lost. The expedition left Valentia on the 7th August, 1857, and the cable continued to be successfully paid out until the 11th August, when it broke in 2,000 fathoms of water, after about 335 miles had been paid out. The dynamometer indicated a strain of 35 cwt. Upon one occasion, before this fracture occurred, the ship had been stopped, and the cable held by stoppers without being paid out, so that it was not the actual weight of the cable which broke it, but, as stated by Sir C. Bright, an omission to ease the break as the stern of the ship was raised by the waves. After this accident the ships proceeded to Plymouth, and the cable was coiled into tanks on shore at Keyham. Upon examination it was found that the cable was injured either by the coiling and uncoiling, or by the original exposure to heat; and several bad places were cut out where the copper wire had forced itself through the gutta percha. The cable was tested at Keyham, and the leakage reported to be high. But as it was not placed in water for fear of corroding the outer wires, no very accurate data were obtained. In the numerous tests made at Keyham the cable was cut in several places, and it would appear that sufficient care was not always exercised in making good the joints afterwards.

In the spring of 1858, the cable was placed on board the ships, and after some preliminary experiments upon paying out and raising portions of the cable, in the Bay of Biscay, it was determined to commence to lay the cable from mid-ocean, between Ireland and America. Two unsuccessful attempts to lay the cable were made, and the vessels returned to Cork; but they started again on the 17th July, and accomplished the successful laying of the cable between Newfoundland and Valentia on the 5th August. The communication between the ships during the paying out was kept up by a pre-arranged series of signals, and doubts were entertained during the laying, of the final success of the cable, from the serious faults which became apparent. On the first occasion a sudden cessation of the current was perceived, but the insulation was good, and after a time the currents came again as strong as before. This could only be accounted for on the supposition that the internal copper wire had broken from the strain, and that when the cable in which it was had reached the bottom the two ends had been brought together again by the elasticity of the sheath. A serious fault of insulation appeared in the cable at about 420 miles from the Irish coast, after which signals could be transmitted only by the use of Professor Thomson's very delicate marine galvanometer. Signals continued to be received, sometimes better, sometimes worse, from the 5th August till the 1st September, when they ceased to be intelligible. Attempts have subsequently been made to repair the cable, but the decay from rust of the outer covering, which, as before mentioned, consists of strands of very fine wires, has prevented the cable being raised without breaking. Mr. Varley in his evidence (Question 2935) states that the speed with which words could be sent through this cable was little over one word of five letters per minute by relay; on Professor Thomson's galvanometer two words per minute were obtained.

We attribute the failure of this enterprize to the original design of the cable having been faulty owing to the absence of experimental data, to the manufacture having been conducted without proper supervision, and to the cable not having been handled, after manufacture, with sufficient care. We have had before us samples of the bad joints which existed in the cable before it was laid; and we cannot but observe that practical men ought to have known that the cable was defective, and to have been aware of the locality of the defects, before it was laid. (*To be continued.*)

THE TELEGRAPHIC SOIREE AT MANCHESTER.

We now place before our readers the remaining contributions of instruments, &c., illustrative of the progressive history of Telegraphy, exhibited at the Free Trade Hall, Manchester in September last.

The Electric and International Telegraph Company.

Five Needle Instrument (Blackwall); Five Needle Instrument (Eastern Counties); Cooke and Wheatstone's earliest Instrument; Cooke and Wheatstone's Double Needle Instrument (Admiralty); Key Double Needle Instrument; Seven Pair of Gothic Double Needle Instruments; Cooke's Magnetic Single Needle Instruments; Brett and Little's Needle Instrument; Hatcher's Rotatory Instrument (South Devon); Hatcher's Rotatory Instrument (Nine Elms); Bain's Cylinder Printing Instrument; Magneto Machine; Hatcher's Magneto Machine; Ditto; Old Resistance Coils (Wheatstone's); Switch Box; Bain's Ordinary Printing Instrument, with Key and Relay; Pair of Morse's Printing Instruments, with Varley's Key, Relay, and Galvanometer; Pair of Single Needle Instruments; Ordinary Double Needle Instrument; Large Alarum; Small ditto; Varley's Vacuum Lightning Conductor; Translator; Undemagnetizable Relay; Ordinary Relay; Pair of Detectors; Single-barrel Switch; Double-barrel ditto.

Professor C. Wheatstone.

Patent of 1837: The first five-needle Telegraph, in which each of the letters of the alphabet is indicated by the convergence of two needles. Communicator or Key-board for the above; another form of ditto; an Electro-Magnetic Bell or Alarum; the original Relay Apparatus.

Patent of 1840: Alphabetical Dial Telegraph, with simple propelling movement; the Working Parts of the earliest form of ditto; Alphabetical Dial Telegraph, with escapement and maintaining power; Ditto, with Relay, and Indicator for doubling the signification of the characters; earliest form of the Magnetic Communicator for either of the above-named instruments; one of the earliest Telegraphic Rheotomes, or Current Directors.

Patent of 1841: One of Professor Wheatstone's first Type Printing Telegraphs, to be worked either by voltaic or magneto-electricity; Communicator for the above.

Patent of 1845: Double Needle Telegraph and Telephone, with a single conducting wire. [With this instrument the signals are both visible and audible.] The first Double Needle Telegraph, with single wire worked by the inverted currents of a magnetic machine; an improved Electro-Magnetic Alarum.

Recent Patents: Universal Telegraph. Patent 1860. Double stations for private telegraphs, with alarums, worked by a single wire and magneto currents. Rate of transmission, 100 letters per minute. Automatic Telegraph, worked by magneto or voltaic currents with a single wire. The apparatus at the distant station is set in motion by the electric current, and the call-bell rung. The Railway Telegraph and Signal Instrument, worked with one wire and magneto current: Patent 1860. Railway Alarm Bell, worked by a single wire and magneto current: Patent 1858. Electric Fire Alarm, indicating two limits of temperature, worked by the expansion of a compound bar: Patent 1860.

Mr. John W. Brett.

An Electric Type Printing Telegraph. [By this instrument the first Submarine Telegraph Message was transmitted and printed in Roman type across the channel from Dover to Calais, by Mr. J. W. Brett, August, 1850.] Keyboard in connection with the above.

Mr. T. Allan.

Pair of Allan's Double Needle Instruments; Dial Instrument; Apparatus to establish communication between the Guard and Engine Driver of a Train; Allan's Automatic Telegraph.

Magnetic Telegraph Company.

Bright's Acoustical Telegraph. [This instrument is the joint patent of Sir Charles Bright and Mr. Edward Bright.] Highton's Single-Needle Telegraph.

Mr. W. T. Henley.

Electro-Magnetic Telegraphs, being those used between the year 1850 and 1859 on the East Lancashire Railway. Pair of Electric Dial Telegraph Instruments. [These Instruments require only one communicating wire.] Pair of Magneto Dial Telegraph Instruments. [These instruments require only one communicating wire.] Large Permanent Magnet.

Messrs. Siemens and Halske and Co.

Railway or Private Line worked by Magneto-Electric Dial Instruments, with Induction Alarum. Signal Instruments for Fire-brigade or Police-stations, as used on the Continent, with Alarum. Two Lines of Railway Alarums: one represented by an Alarum and a Magneto-Electric Battery, the other by an Alarum, to be started by interrupting the continuous current of the line. General Telegraph Line. Three stations (two end and one translation) with one direct working polarised ink writer, one magneto-electric key, two embossing instruments, polarized relays and batteries. Telegraph Line for speaking through a single wire in both directions at the same time. Two stations represented by two recording embossing instruments, with relays and batteries. Two Electro-Magnetic Dial Instruments. Siemens and Halske's construction of 1847. Apparatus for Perforating Strips of Paper, to prepare them for the automatic transmission of messages; also the transmitting apparatus employed. Constructed in 1851.

Mr. H. Wilde.

The Globe Telegraph, 1861.

Mr. Sortais.

Automatic Instrument applied to Morse's Telegraph, by which the clock work is set in motion by the electric current, and stopped when the message is completed.

M. Breguet.

French Double-Needle Telegraph. [This instrument was for a long time exclusively used by the French Government.] An Improved Morse's Printing Instrument with Signal Key, marking the signals in ink. French Alphabetic Telegraph: Receiving Instrument. French Alphabetic Telegraph: Transmitting Instrument. Vertical Boussole; Vertical Lightning Conductor Alarum.

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MR. LISTER.

A Papier Machó Model of Cooke and Wheatstone's Double-Needle Electric Telegraph and Batteries; Ditto of Bain's Printing Telegraph; Ditto of Bright's Bell Telegraph and Manipulating Key.

MR. EDWARD BRIGHT.

Fire Alarm caused by the Battery Circuit being completed through the expansive agency of heated mercury; Bell for the above.

MR. W. REID.

Pair of Double Needle Instruments.

MESSRS. NEWALL AND CO.

Specimens of the following Submarine Cables, constructed by Messrs. Newall and Co.: England and Holland; England (shore end); Dover and Calais; Dover and Ostend; across the Zuyder Zee; Port Patrick and Donaghadee; Denmark, across the belt; across the Mississippi; Varna and Balaklava; Channel Islands (two specimens); Red Sea (two specimens); Atlantic.

MR. W. H. PREECE.

Specimens showing the effect of kinks in Submarine Cable; also the injuries resulting from ships' anchors and abrasion on rocks. Stone picked up in 25 fathoms of water, wherein a cable has been embedded.

ELECTRIC AND INTERNATIONAL TELEGRAPH CO.

Collection of Insulators on pole. Specimens of Submarine Cables.

MAGNETIC TELEGRAPH COMPANY.

Collection of Insulators, including Bright's bell insulator, spindle and shackle.

MR. O. ROWLAND.

Model of Rowland's Inductometer. Electrometer employed for testing for insulation for the Government Cable Experiments' Committee.

DR. J. SHAW.

Model of patent method of insulating and laying down Telegraphic wires.

HERR FABER, Director of Telegraphs, Copenhagen.

Specimens showing the present mode of insulating wires on the lines of the Royal Danish Telegraph. Also Battery. All of original Danish construction.

PROFESSOR W. THOMSON, LL.D., and MR. FLEEMING JENKIN.

Professor Thomson's Patent Marine Galvanometer, an instrument by which galvanometric observations can be made at sea, with accuracy, in the roughest weather. Patent Daniell's Battery, without porous cell or diaphragm. A cheap, portable, and constant battery.

MESSRS. ELLIOTT BROTHERS.

Resistance Coil, and Wheatstone's Bridge. Peltier's Electrometer.

MR. CULLEY.

Gaugain's Tangent Multiplier.

PROFESSORS ABEL and WHEATSTONE.

Apparatus for Exploding Mines by means of Magneto-Electricity.

THE ATLANTIC TELEGRAPH COMPANY.

The Message sent by the President of America through the Atlantic Cable.

DR. CATTELL.

Specimens of Gutta Percha purified by Dr. Cattell's process.

MR. DODWELL.

A Collection of Portraits of eminent Electricians.

MESSRS. BRIGHT and CLARK.

Microscopical Specimens of Submarine Soundings. Specimens of Marine Deposits on Submarine Cables. Picture of Valentia—the ships employed in submerging the Atlantic Cable: the Agamemnon and Niagara. Stereoscopic Views taken during the survey for the North Atlantic Telegraph.

MESSRS. SIEMENS and HALSKE.

Cast Iron Bell Insulators for stretching and intermediate posts. Specimens of Wire insulated with India-rubber by Siemens's covering process without the application of heat. Electric Resistance Thermometer with balancing coil and differential Galvanometer.

MESSRS. REID BROTHERS.

Specimens of Insulators and Battery Cells.

MR. J. W. BRETT.

Two cases containing—Specimen of the first experimental Submarine Electric Telegraph line laid from Dover to Calais, August, 1850. Projected by Messrs. Brett, 1845. Specimen of the permanent line. Laid down September, 1851. Specimen of the same Cable after being submerged 6 years. Specimen of the Dover and Ostend Cable. Laid down May, 1853. Specimen of the Spezzia and Corsica Cable. Laid down May, 1854. Specimen of the Sardinia and Algiers Cable. Laid down 1856. Specimen of the Cromer and Denmark Cable. Laid July, 1859. Specimen of the Folkestone and Boulogne Cable. Laid June, 1859. Specimen of the Beachy Head and Dieppe Cable. Laid June, 1861. Specimen of the Atlantic Cable. Laid August, 1858. Specimen of the Core of the same, showing the different layers of Gutta Percha, and also the manner of making a join in the conductor. Specimen of the Cable approved by Mr. J. W. Brett, for the Atlantic Cable. Part of a Kedge Anchor, with hemp rope attached, showing the effect of submergence. A Pistol, showing the same thing.

DISTRICT AND PRIVATE TELEGRAPHY.

THE extraordinary rapidity which characterizes the development of this important and useful branch of telegraphy, is strikingly manifested in the net-work of wires which traverses the Metropolis from one end to the other. In the early part of 1857, a short line was constructed in the city; but more than two years elapsed before the advantage of so cheap and efficient a system of construction was fully appreciated. At first the difficulty encountered in obtaining the requisite permission to pass over private and public properties, and to ascend the numerous roofs of houses along the line was often extremely harassing, but as the work progressed, a knowledge of its nature and character gradually removed those obstacles. The success which attended the adoption of the system by one or two private firms, resulted in the formation of two public companies—the London District Telegraph Company, and the Universal Private Telegraph Company. The former company have no less than 70 stations in the metropolis and its suburbs, for the transmission and receipt of messages. The company also construct and maintain a considerable number of private telegraphs.

The other Company was established for the construction and maintainance of private telegraphs exclusively. The method adopted by this Company for conveying the conducting wires is a peculiar one. Fifty copper wires, more or less, are coated with caoutchouc, then formed into a cable, and served with an external coating of tarred hemp. The cable is supported by a series of suspenders, attached to two stout strands of iron wires, from iron standards fixed upon roofs at certain intervals. The lines have answered the purpose remarkably well, not having been affected by exposure to atmospheric influences or heat.

The advantages derived from such an instantaneous means of communication between Government Offices, Commercial and Manufacturing Establishments, &c., is sufficiently evident in the rapid progress of the system.

Another highly interesting feature in the development of private telegraphy is its introduction between the various establishments of the Daily Journals and the Houses of Parliament. The next session will open a new era in the art of reporting; by adequate arrangements, the speeches and debates may be transmitted to the remotest towns with the same facility and expedition as to the nearest establishment in the metropolis.

VOLTAIC COUPLES OF ONE METAL.

THE use of porus partitions between the elements of a voltaic couple, and the employment of two solutions, as the "exciting fluids" appear to have been first adopted by Sir H. Davy, who discovered that by these means a couple may be formed with two plates of the same metal. By interposing between plates of iron pieces of cloth moistened with dilute acid or with a solution of alum, over which are placed pieces of animal membrane, moistened with pure water, a voltaic pile may be constructed, which, however, continues in action but for a short period, owing to endosmosis through the membrane. A more permanent arrangement may be made by moistening the cloth with a solution of the sulphate of copper. It might be supposed that in this case the action arises from the presence of metallic copper as an element of the couple; but this view is disproved by the fact that the deposit of copper is not, in many cases, in metallic contact with the iron, and that the action ceases almost completely when the metal is reduced from solution. A trough, similar to that of the Cruikshank's battery, but with plates of iron coated on one side with plaster, in lieu of the compound plates of zinc and copper, affords a more convenient mode of exhibiting the phenomena of a single-metal battery. The divisions may be filled up with a solution of sulphate of copper. With a certain number of alterations, the copper is deposited in a fine state of division without adhering closely to the metal plates. The removal of the copper by means of a brush or feather *increases* the power of the battery; thus shewing that the reducing action, and not the reduced metal, occasions the efficacy of the arrangement. It is probable that where economy of consumption is the object mainly in view in obtain-

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ing the supply of voltaic power, a battery similar to the above might with advantage, be employed.

It has recently been proposed to utilize the action we have referred to in the construction of "reducing tanks," for obtaining copper from solutions, after its extraction from poor ores of the metal by what is known as the "moist process." At the Alderley copper mines, near Manchester, and elsewhere, a solution of copper in the form of a chloride is obtained by the action of muriatic acid upon the prepared ore; the metal being subsequently reduced by means of scrap iron. By arranging the iron in the form of a single-metal couple, the elements of which are separated by a layer of plaster, the copper is reduced with far greater rapidity upon the negative element, with the production of a voltaic current which might be utilized in various metallurgical operations now objected to on the ground of expense. By uniting together several of the voltaic reducing tanks by their opposite poles, the reducing action is of course greatly accelerated. The same process affords a means of obtaining from solutions any metal which is negative in regard to iron.

With an *insoluble* metallic salt, such as the bi-chloride of copper, or the sulphate of lead, a single-metal couple may be constructed, with plates disposed horizontally, without employing the porous partition. The same principle has been adopted in the construction of several forms of battery to which we shall have occasion to refer.

Correspondence.

STANDARDS OF ELECTRICAL MEASUREMENTS.

SIR,—I have read with much interest your very practical and sensible observations upon the above important subject. It would be very desirable that electricians should be made acquainted with the names of the gentlemen to whom the matter is referred by the British Association, so that they might communicate any views or suggestions which they may have on the subject. Many of the methods now adopted are exceedingly abstruse, entirely beyond the comprehension of the class of men who have the practical management of the manufacturing and testing of telegraphic materials and apparatus. As you very properly observe, the system of measurement must be "sufficiently simple and easy of application to meet the requirements of the telegraphist." I trust that the Commission will not lose sight of the suggestion.—Yours, &c., TYRO.

To the Editor of THE ELECTRICIAN.

SIR,—I have seen a Peltier or Milner Electrometer, in which the brass-work carrying the needle is insulated from the stand of the apparatus by means of a compound of gum *dammar*. Can any of your correspondents inform me of the nature of this substance, whence obtained, and whether it is to be found in commerce? Its insulating properties appear to be most perfect, and, if not too expensive, it might receive valuable applications.

Nov. 14, 1861. A SUBSCRIBER.

To the Editor of THE ELECTRICIAN.

SIR,—Can you kindly refer me to any book containing ample information what thickness and length of insulated wire to use to get the greatest amount of magnetism out of a bar of soft iron of a given size? Also, whether a translation of Becquerel's Electrical Treatise can be obtained, or do you know any other book which goes deeply in the formation of crystals by electricity?—Yours respectfully,

A SUBSCRIBER FROM THE FIRST, (*Haverfordwest.*)

[WE do not know of any work giving *ample* information on the subject of our correspondent's first question. It may be stated, approximatively, that the power of an electro-magnet depends upon the "quantity" of the current traversing the helical wire, and also upon the proximity of the coils to the soft iron. Thus the power depends more upon the battery employed than upon the construction of the magnet. The latter, if coiled with thick wire, will be influenced to a very small extent by a battery of a hundred or more small couples connected by their opposite poles, *i.e.*, as a *tension* arrangement. If constructed with a great length of *fine* wire, it will be scarcely affected by a single couple, however large may be the plates; the tension of the battery being insufficient to overcome the resistance of the wire. By using the latter, or quantity, battery, with the electro-magnet coiled with a helix of thick wire, in short circuit, the full power of the magnet may be obtained. Such a magnet, however, would be useless in a circuit offering any considerable resistance. To obtain the greatest amount of power, and to avoid waste, the magnet must be constructed with due regard to the quantity of electricity, which, with a given battery power can pass through the circuit of which the helix of the magnet forms a portion. To place the question on a practical basis, and to give data to enable the telegraph engineer at once to determine the best form of magnet for a line of given resistance, and a battery of given tension, would be a work of some difficulty. We do not believe that this has ever been attempted; although Mr. T. Allen and others have lately given much attention to the economical production of electro-magnetic force. We have failed to discover whether there is an English translation of the work of M. Becquerel referred to. In vol. 8 of the French work, p. 287, *et. seq.*, some interesting information is given, as you are probably aware, on the subject of decompositions and crystallizations effected by the aid of weak voltaic currents. See also "Taylor's Scientific Memoirs," vol. i, p. 414; *Comptes Rendus*, Feb. 1852; and *L. and E. Phil. Magazine*, N.S., vol. iii, p. 235.—E. E.]

Miscellanea.

THE FIRST ENGLISHMAN WHO SAW A GALVANIC TELEGRAPH PUT IN ACTION.—"So we know now, that the Honorable Francis James Lamb, third Viscount Melbourne, and brother to Lady Palmerston, was the first Englishman that ever saw a telegraph put in action by a galvanic battery, and that it was the Russian Baron Schilling who invited him to take notice of it."—*Dr. Hamel's Historical Account, &c.*

ELECTRICAL ENDOSMOSIS.—It was first remarked by Porret and Becquerel, that when a mass of liquid is separated into two compartments by a porous diaphragm, and subjected to the action of an electric current, the liquid is transported from the compartment of the positive pole to that of the negative one, so that in the latter the level of the liquid rises, while in the other it experiences a corresponding fall. This is called *endosmosis*. Wiedemann subsequently showed that the quantity of water thus conveyed from one compartment to the other was directly proportional to the intensity of the current, and to the electric resistance of the liquid. With a view to ascertain whether this phenomenon might not be ascribed to a secondary action of electrolysis (decomposition by electricity), M. Matteucci has instituted a series of experiments, which he last week communicated to the French Academy of Sciences. Having formed a pile of six compartments, with porous diaphragms or partitions, and filled them all with pure water to the same level, marked by a line of white paint, he put a lamina of platinum of the same breadth as the diaphragms into each of the extreme compartments, and then sent a current through them, furnished by from ten to twenty of Grove's elements. After the lapse of a few hours endosmosis became apparent; the liquid rose in the compartment of the negative electrode, and fell in that immediately next to it. It likewise fell in that of the positive electrode, but less than the rise already mentioned in the negative compartment, another rise being apparent in the compartment immediately next to the positive one. In the intermediate cavities the liquid remained stationary for a long time, but at length the water in the compartments on the positive side rose, while it fell in proportion in the others. M. Matteucci having found that the liquid around the positive electrode always acquires a degree of acidity, while that round the positive one, on the contrary, acquires a corresponding degree of alkalinity, thence concludes that the presence of electricity, and the state in which the elements of electrolysis present themselves, gives them properties which induce endosmosis, and which only act in the presence of an electric current.

OZONE.—Schonbein has been industriously following up his researches respecting the presence of this peculiar and most important agency in the atmosphere. He has just found that when a strip of paper, moistened with a solution of pyrogallic acid, is introduced into an atmosphere containing ozone, it is rapidly darkened; whilst, if no ozone be present, the paper retains its original whiteness. A test of this body ought to be as common in a house as a barometer. The test recommended by Dr. Angus Smith, Miss Nightingale, and others, as we have before remarked, is the alkaline permanganates, or Condy's fluid, which, besides, is itself a vehicle of ozone; and, as a free contributor of it, is in extensive use as a sanitary agency identical in its nature with the very ozone of the atmosphere itself—the great scavenger and cleanser of nature. Ozone is almost equivalent to health. In crowded cities or unhealthy neighbourhoods it is scarcely ever to be detected; whilst, on the ocean, the sea shore, or elevated open tracts of country, it is almost invariably present in quantity. The first outbreak of an epidemic, such as cholera, is always heralded by a rapid decrease of ozone in the atmosphere, whilst its reappearance is almost as certain a sign of the cessation of the sickness. Ozone appears to be essentially electrified oxygen; and that, in truth, is the vital air which we breathe, and which sustains life and health. Were the oxygen of the air entirely neutral, or unelectrified, it is doubtful whether it could sustain life, or constitute vital air at all.—*Builder.* [In the last phrase our contemporary is in error. Ozone itself is very poisonous, and directly destructive to animal life. Indirectly its action is of course beneficial; but we do not require electrified oxygen for the purpose of respiration.—E. E.]

LENOIR'S GAS ENGINE.—The very ingenious new motive power, invented by M. Lenoir, seems to meet with approval in scientific circles in Paris. It is simply the application of common gas, exploded in small quantities above and below the piston of what was once a *steam* engine, the explosions being ingeniously regulated, and produced by the electric spark from a Rhumkoff machine. The piston moves regularly and rapidly, precautions being taken to avoid accident. The expense of gas is small, 500 litres per hour for each horse-power, ten hours' work costing about 1s. 3d. per horse-power. This invention is about to be applied to locomotives; and as the gas required may be produced by the decomposition of water itself, a great revolution in machinery may result.

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The Electrician.

VOL. I. No. 3.—NOVEMBER 23, 1861.

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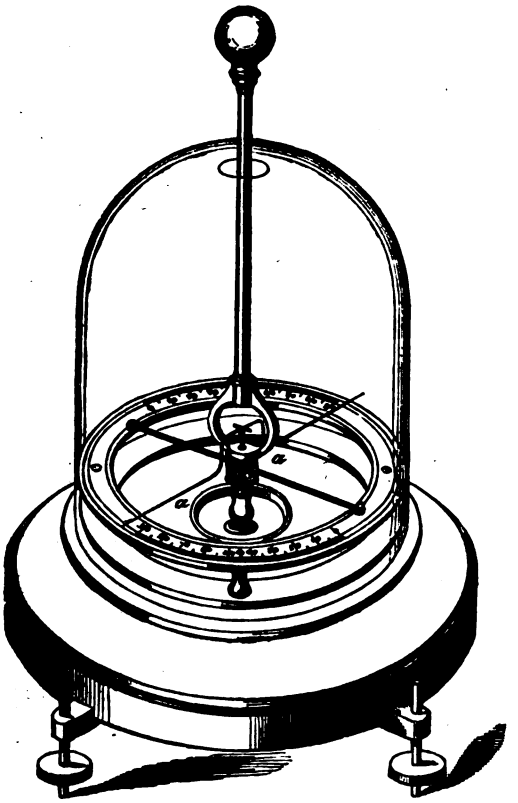

THE MILNER ELECTROMETER.

THE MILNER, or, as it has been generally termed, the PELTIER Electrometer, has lately become an instrument of great importance in regard to the practical applications of electricity. According to Mr. LATIMER CLARK, it was in all its essential parts first described and illustrated by Dr. THOMAS MILNER, in the year 1733. The instrument described as the invention of PELTIER in the Report of the British Association, 1849, and termed the Induction Electrometer, is constructed as follows:—A hollow ball of copper four inches in diameter is connected with a rod of the same metal, which is terminated at its lower extremity with a much smaller one. The latter is attached to a copper stem contained within the glass shade which protects the lower portion of the instrument, the metal being insulated from the surface of the glass by means of a portion of shellac. The copper stem, at its lower extremity, bifurcates and forms a ring, in the centre of which a long copper needle moves freely upon a pivot. In a horizontal direction from each side of the ring project two rods of copper, with which the suspended needle comes into contact when it is allowed to move until it comes into the same vertical plane. The lower part of the stem is insulated by means of shellac contained in a glass tube fixed into the wooden stand of the instrument. Attached to the upper portion of the copper needle, and parallel to it, is a very small magnetic needle, which serves to keep the former in its normal position, *i. e.*, in contact with the horizontal brass rods.

As constructed by PELTIER, the instrument was intended solely for observing the effects of induction upon the large ball of copper. In the improved form of the instrument, as at present made, this large ball is dispensed with. The brass stem rises from the centre of the wooden stand, and is insulated from it by means of *ebonite* (vulcanite), a compound of *dammara resin* (gum-dammara) with caoutchouc and shellac, or other very perfect insulating material. As seen in the figure, the insulated stem carries two brass arms terminating in small knobs, and a little higher up it opens into a ring, through which passes an aluminium or other light metallic needle. At some distance below the needle is a graduated circle, and beneath this is a circular plate of looking glass. In reading the deflections of the needle, the latter should appear to the eye to cover its own image in the glass, so as to avoid parallax. The glass shade which covers the instrument has a small aperture at the top to allow the stem with its brass knob to pass out for a small distance above it.

Having adjusted the position of the instrument so that the magnetic needle, which now is generally placed at right angles to the indicating needle, may be in the magnetic meridian, the projecting brass rod may be touched with a conducting substance, so as to ensure the insulated metal being of the same electrical tension as the earth. To observe the effects of induction, we may now excite a positive or negative electric, and hold this at some distance above the instrument. The metallic needle will immediately be deflected, owing to the action of the air as a di-electric. If the electric be positive, the negative electricity of the insulated metal will be accumulated in the upper brass knob, and the needle will be deflected by the repellent action of the positive charge in the lower portion of the instrument. This charge may be removed by touching the lower portion of the stem with a conductor—the upper portion being still under the influence of the external electricity; and the needle will then fall to zero. If now the excited electric be removed, the needle will again be deflected by the distribution of the negative electricity.

In testing the *insulating power* of various materials, the instrument may be charged to a certain tension, indicated by the needle, by bringing an excited electric into contact with the brass ball. The charge is communicated far more rapidly when a short piece of fine platinum or copper wire is attached to the ball. The materials to be tested should be carefully dried on their surface, and, if hygroscopic, partly covered from the air by a varnish or otherwise. The time taken by the needle in falling a certain number of degrees when the body to be tested is in contact with the instrument at one extremity, and in connection with the earth at the other, is then carefully noted. In very delicate experiments the air within the glass shade should be dried by means of chloride of calcium contained in a small vessel, and strong currents of air, or even the passage of the breath, over the instrument should be avoided.

The tension of the poles of a battery arrangement, *i. e.*, the electro-motive force of the latter, may be observed simply by bringing one of the terminal wires into contact with the knob of the instrument. If the opposite pole be placed in contact with the earth, the tension indicated will be twice the amount of that which is shown when the wire is insulated from the ground.

In atmospheric observations the instrument may either be charged with free electricity, and the indications of the needle noted at certain intervals, or it may be brought to the same degree of tension as the earth, and the inductive effects of the atmosphere upon it observed. Owing to its greater convenience, the former method is now generally adopted; but the variations of the needle under atmospheric influences are far from being understood or reduced to a system.

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A regular and uninterrupted series of atmospheric observations by noting the induction effects upon the PELTIER instrument, were made by M. QUETELET, at the Royal Observatory at Brussels, from the beginning of August, 1844, till the end of December, 1848.* A strong inductive influence was generally noticed at the approach or cessation of rain. The *maximum* of atmospheric electrity was indicated in the month of January; the tension of the atmospheric charge diminishing progressively until the month of June, when it attained its *minimum*. The difference of the tension in these two months was in the proportion of 13 to 1. The results obtained by Mr. RATCLIFFE BIRT, at the Kew Observatory, are closely in accordance with those of M. QUETELET.

In the atmospheric observation made with the *induction* electrometer, the instrument is placed upon a stand raised about six feet; and the base of the stem is then touched with a conducting wire so as to bring this portion of the metal into equilibrium of tension with the earth. When the instrument is removed from the inductive influence, it indicates the presence of free electricity by the deflection of the needle. The nature of the charge can readily be ascertained by approaching an excited electric to the upper portion of the instrument. When the charge is positive it indicates a negative atmospheric tension and *vice versâ*.

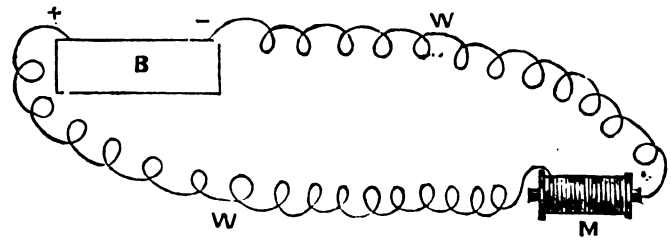
That insulation is merely a question of degree may, with most substances which are considered as non-conductors, be readily ascertained by the MILNER Electrometer. In very perfect instruments, however, a near approach to complete insulation must be obtained, in order that the charge may be retained for any length of time. This appears to be effected by the compound of india-rubber with gum-dammara with shellac, and in many cases also simply with vulcanized caoutchouc or *ebonite*.

The foregoing observations may be of some interest to those who are unaquainted with the use of this beautiful instrument. For the purpose of obtaining accurate measurements in practice, the MILNER Electrometer is susceptible of great improvement. As at present constructed, it is, in its action as an indicator of electric tension, analogous to the ordinary galvanometer as an indicator of quantity in dynamic electricity. It, therefore, possesses the defects of the common galvanometer (in which the action upon the magnetic needle of the current passing through the coils, varies according to the position of the needle with respect to the latter), inasmuch as the scale of measurement is irregular. We hope shortly to be able to give a description of an improved form of MILNER'S Electrometer, contrived by Mr. LATIMER CLARK, in which the principles of the *sine* and *torsion* galvanometers are applied in order to obtain an accurate scale of measurement. In another modification we have seen of the instrument the action is sufficiently delicate to indicate the tension of one couple of DANIELL'S battery.

THE ELECTRO-MAGNET.

THE importance of the Electro-Magnet, as an essential part of nearly all the telegraphic apparatus now in use, renders the economical application of this instrument of peculiar interest to the practical electrician. A needless augmentation of the effective resistance in a circuit, and a consequent waste of battery power, often follows from a disregard of the laws which have been established in electro-magnetism. On the other hand, it is generally impossible in practice to fulfil all the conditions required by theory to ensure the greatest amount of efficiency in the arrangements for employing the electro-magnetic agency. For instance, the *maximum* of power in an electro-magnet is obtained when the resistance of the wire coils of the magnet is equal to that of the remaining portion of the circuit. But when an instrument is used indiscriminately for long or short circuits, it is impossible to adopt the principle of construction involved in this fact. The power of the magnet is therefore in most cases necessarily below the *maximum*. In no case, however, should the resistance of the magnet be greater than that of the external circuit (including the battery resistance).

Adopting the nomenclature of the system of electrical measurement lately proposed by Mr. CLARK and Sir C. BRIGHT; let B represent a voltaic arrangement capable of giving a current of 50 *milliogolvats*, w w, a wire offering a resistance of 30 *millivolts*, and M an electro-magnet coiled with fine wire with a resistance of 20 millivolts, or a conductivity less by one-third than that of the wire.



In this case the full power of the electro-magnet is obtained, apparently without loss of battery power, as the whole of the electricity which is generated traverses the circuit. A little consideration will, however, show that if the conductivity of the coil be increased to 30 millivolts, so as to equal that of the conducting wire, the same *quantity* of electricity would traverse the arrangement at a lower degree of *tension*. By thus reducing the resistance of the coil, the number of alternations in the battery arrangement may be diminished; and, at the same time, the amount of surface may be increased, with a corresponding increase of quantity in the current, upon which depends the force of the electro-magnet. With a battery of greater or less power the expediency of reducing the resistance of the coils is still more obvious.

In circuits which include a number of electro-magnets, it is generally impracticable to give to any single coil a resistance at all approaching that of the entire circuit. In the *circuit-magnets* of the French overland telegraphs, a resistance equal to 200 *kilomètres* of the ordinary line wire is found to answer every requirement of the service, The wire is sufficiently fine to give about 2,000 turns in the coil. The relay-magnets are of course constructed with a short coil of stout wire.

The following is the law of MM. LENZ and JACOBI relative to the power of electro-magnets:—

The magnetic intensity developed in a bar of soft iron is proportionate to the product of the *intensity* of the current by the number of turns in the wire which forms the coil of the magnet.

It should be observed that the expression *intensité*, as applied by foreign electricians to the voltaic current, is of somewhat indefinite meaning, referring to the general strength of the current, without special reference either to its tension or quantity. As shown by MULLER, the above law applies only when cylindrical bars of soft iron of moderate length are magnetized by means of a current from one or several couples of ordinary dimensions. The researches of MULLER also establish that, under similar conditions,

The magnetic intensity developed in bars of soft iron, is proportional to the square roots of their diameters.

The same distinguished philosopher has also shown, that for each bar of iron, there is a *maximum* of magnetic effect, beyond which the power cannot be increased. This *maximum* of magnetization is proportionate to the square of the diameters of the iron.

A serious cause of imperfection in apparatus in which the agency of electro-magnets is employed, exists in the residual magnetism which, more or less, always remains in the iron after the circuit has been broken. The amount of this residual magnetism depends in great measure upon the quality of the iron.

* Annales de l'Observatoire Royal de Bruxelles, t. vii., 1849.

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The interposition of a substance such as a thin sheet of paper between the poles of the magnet and the armature, has the effect of promoting to a considerable extent the rapid demagnetization of the bar of soft iron, by which the speed of transmission is determined.

Some curious facts relating to various forms of the electro-magnet were ascertained by the late Dr. RITCHIE. When the electro-magnet is very short, and the poles near each other, its retaining power is very inconsiderable; when the magnet is very long in proportion to the diameter of the iron, the retaining power is very great. Another singular fact is, that a short electro-magnet, though of considerable lifting power, is incapable of inducing permanent magnetism in an unmagnetized horse-shoe of tempered steel; while an electro-magnet of four feet in length, though of no greater lifting power than the small one, is capable of inducing a very considerable magnetic effect.

An extended and valuable series of papers on the subject of electro-magnetism has been published by Prof. NICLES, of Paris.* These researches establish, that up to a certain point, which varies according to the tension of the current, the increase of length in a bar of soft iron augments the degree of magnetic intensity which may be developed in the iron. M. NICLES attributes this effect to the diminution of the neutralizing influence of the two opposite poles upon each other, by the increase of the distance between them. In the ordinary horse-shoe magnet, no increase of the magnetic effect was occasioned by lengthening the arms of the magnet. Within a certain limit, the intensity of the horse-shoe magnet was augmented by increasing the distance between the poles. The advantage, in point of diminished resistance, offered by several forms of magnet with compound helices, is also fully considered by M. NICLES.

Review.

TELEGRAPHIE ELECTRIQUE. Par J. GAVARRET, Professeur de Physique à la Faculté de Médicine de Paris. Victor Masson et Fils, Place de l'Ecole de Médicine, Paris.

THOSE of our readers who have perused the very complete and lucid exposition of electrical science in the *Traité d' Electricité* of M. Gavarret, will welcome this new work by the same author, which treats of electricity applied to telegraphic communication. Assuming on the part of his readers a knowledge of the elementary principles of electrical science, M. Gavarret divides his subject matter under the following headings: Chapter I., On the Telegraphic Line, is devoted to the study of the electro-dynamic circuit. Chapter II. treats of the various descriptions of Telegraphic Instruments: Needle Instruments, Dial Instruments, Writing or Printing Instruments, Railway Signalling Apparatus, &c. Chapter III. describes the arrangement adopted for telegraphic correspondence, and the various disturbing influences which may interfere with the transmission of signals. To these is appended a series of copious and valuable notes in which various questions of a more abstruse character are treated mathematically. The volume extends to upwards of 400 pages, and is illustrated by a number of very beautiful wood engravings similar to those contained in the *Traité d' Electricité*. The style is very concise and clear, and the matter arranged with method. A brief account of the origin and progress of electro-telegraphy precedes the body of the work.

It will be seen that this work, though scarcely adapted as an introduction to practical electrical science for beginners, should be of considerable interest to all who are engaged in telegraphic manipulation. It is an encouragement to telegraphic progress and extension, to find the subject so carefully and ably treated by so high an authority in electrical science, as the author of this treatise. "We cannot but perceive," observes M. Gavarret, "that electro-telegraphy is far from having attained its highest degree of perfection. As telegraphic lines become multiplied and extended, new difficulties arise; and every philosophic mind must be convinced that a careful study of the mode of propagation of the electrical agency can alone supply the elements of future progress in this beautiful application of physical science."

Passing over the first and second sections of the first portion of the work, in which the methods of establishing aërial and subterraneous wires are described; we find in the third section some observations bearing upon the question of the external covering of submarine wires. The necessity for adopting the strongest protecting wire for cables to be laid in shallow water is duly insisted upon. "During severe storms," says M. Gavarret, "the agitation of the water often reaches to a considerable depth, and is sufficient to determine the friction of such cables upon the rocks, an action which speedily effects the destruction of the cable." Thus the storms of January, 1857, resulted in the failure of every line of communication between England and the Continent. In deep-sea cables, on the other hand, the principal, and almost the only object of the external armature, is to prevent the rupture of the cable during the operation of laying. The specific gravity of the interior portion of the cable being but little greater than that of water; the weight of the line when once immerged depends almost exclusively upon the size of the external armature. The strain upon the cable during submersion is, therefore, nearly proportionate to the section of the wires composing this armature. On the other hand, the amount of sectional surface of the wires supporting the weight is proportionate to the thickness of the armature. The resistance to breakage, remains, therefore, almost the same whether the external covering be light or heavy. But the light cable is more flexible, more manageable, cheaper, and easier of transport than the heavier one, and offers far greater facility in laying. It is thus with reason that the adoption of light cables for considerable depths has generally been advocated.

In the section on *The Earth employed as a Conductor*, the instructive experiment of M. Guillemin, in which the galvanometer indicates the passage of a current produced by the rapid charging and discharging of a Leyden bottle, of which the exterior and interior coatings are connected with the poles of a voltaic arrangement, is described and illustrated. The following passage explains the mode of conduction, and the causes of resistance, in the earth portion of the circuit:—"It is not correct to assume that the current, after having traversed the wire, returns to the battery through the action of the earth as a simple conductor. This opinion could be maintained only in cases where the points of contact of the poles of the battery with the earth are at a short distance from each other; but when these points of contact are separated by a great number of *kilometrès*, the layers of the earth stand in the relation to the poles of the electrometer of a conductor, having a surface of infinite extent, absorbing the electricity as it is generated, maintaining at *zero* the tension of the extremities of the conductors in contact with it, and allowing the evolution of electricity to continue until the active metal or fluid of the battery is entirely consumed. Thus the earth opposes two kinds of resistance to the propagation of electricity—the one passive, the resistance to *diffusion*, the amount of which depends upon the nature of the soil and the extent of the surfaces in contact; the other *active*, due to the polarization of the electrodes, an inevitable result of the decomposition of the moisture of the earth. The sum of these two resistances, or the total resistance of the earth, necessarily varies in inverse ratio to the extent of the earth plates and the conductivity of the surrounding soil, and evidently preserves a constant value, independent of the length of the telegraphic line. We must, however, add that when a good communi-

L'Institut, 8 Décembre, 1852. *Comptes Rendus de l'Académie des Sciences*, 1853, t. xxxvi. p. 490; t. xxxvii. p. 955; 1854, t. xxxviii. p. 266 & 397; t. xxxix. p. 635. *Bulletin de la Societé d'Encouragement*, Mai & Juin, 1853. *Memoires de la Societé de l'Académie de Stánislas*, Nancy, 1853. *Les Electro-aimants*, Paris, 1860.

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cation is established with a moist soil, or still better, with a natural stream of water, diffusion is effected with extreme facility, and the resistance of the earth is always very weak when compared with that of a telegraphic conductor of a certain length."

The experiments of Matteucci proving that the substitution of the earth for the return wire "augments the intensity of the current;" or, as we would rather say, diminishes the total resistance of the current, allowing a greater portion of electricity to pass along the wire, are detailed in this portion of the work.

The section *On Electromotors* is of considerable interest, as it includes a description of two forms of battery combination, which are but little known in England, viz., those in which a sub-sulphate of mercury and the sulphate of lead are respectively used as exciting agents.

The first arrangement noticed by M. Gavarret is the "sand battery," termed by him the *pile Anglaise*, though its employment in this country is now by no means general. The advantages of the sand battery, in point of general convenience, are duly referred to, as also are its small electromotive power and high resistance. Bunsen's battery is alluded to only to point out the impossibility of employing it by reason of the nitrous vapours it evolves. The Daniell's battery is almost universally employed in France, though there is some reason to believe that it may eventually be superseded by that we shall proceed next to describe. In the French form of Daniell's battery, contrived by Bréguet, the *copper* element is contained in the porous vase, and is very small in dimension in comparison with the zinc element, which forms a cylinder surrounding the vase. It is a matter of some practical importance to ascertain the comparative economy of this plan, and that which is adopted in our usual form of this battery,—due regard being paid to the *quantity* of the current in each case. The French form of battery has been found to continue in activity for a period of two months and twenty-two days, at the end of which time the addition of a few crystals of sulphate of copper in the negative compartment sufficed to restore its original energy.

Couples of two different sizes are employed on the French lines, the larger size being for the local circuits, the smaller for the line circuit.

To determine the number of elements required to work the line, a sine galvanometer with twelve turns of wire is placed in circuit, and the number of couples increased until the needle of the instrument is maintained at a deflection of 8°, indicating the amount of current which experience has shown to be necessary to influence the receiving instruments.

In the sulphate of mercury couple, contrived by Marié-Davy, the copper element of the *French form* of Daniell's battery is replaced by a cylindrical rod of graphite, the space around which in the porous cell is filled up with a pasty mass of sub-sulphate of mercury, $SO_3\ Hg_2O$. From our own experience of this arrangement, we can pronounce it in many respects superior to that of Daniell. In the batteries we have constructed, the porous cell was dispensed with; the elements being arranged horizontally, the graphite element beneath and covered with the insoluble sub-sulphate. The electro-motive force of the couple of Marié-Davy is at least one-third higher than that of Daniell's couple. Its resistance, however, is greater; but, as shown by M. Gavarret, the battery resistance is generally very inconsiderable when compared with that of the line wire, and the advantage gained in increasing the electro-motive force of the battery is much greater than that which would result by decreasing its resistance. The sulphate of mercury battery remains in action without attention for a longer period even than that of Daniell. It is to be observed that its power is shown only in a circuit of considerable resistance. When in short circuit, though the current at first is very powerful, it rapidly decreases in quantity and tension owing to the energetic action of the charcoal upon the mercury salt.

The last-mentioned effect also takes place in the couple with sulphate of lead as an exciting agent, also invented by M. Marié-Davy. Batteries constructed with this couple have the advantage of taking up very little space. They are composed of a series of wrought-iron dishes, tinned to preserve them from corrosion, to the under surface of which are attached plates of zinc. A layer of sulphate of lead, and water or a solution of common salt, are placed in the interior of each vessel. The couples are then arranged in the form of a voltaic pile. This battery is stated to be under the consideration of the *Administration Centrale des Télégraphes.*

(To be continued.)

BISHOP WATSON AND THE ELECTRIC TELEGRAPH.

BY DR. HAMEL.

At the Telegraph *Soirée*, which took place in September last, at the Free Trade Hall at Manchester, during the meeting of the British Association for the Advancement of Science, Mr. W. R. Grove, F.R.S., well-known as the inventor of one of the forms of a voltaic battery, addressed the numerous assembly, and gave a sketch of the history of the rise and progress of the electric telegraph.

He began by repeating the statement made by some authors, that Bishop Watson had given the first idea of an electric telegraph.

Now, as Bishop Watson never in the least occupied himself with electricity and electric telegraphy, I think it right to offer an explanation, especially as I had occasion, some years ago, to point out the incorrectness of such a statement to the Imperial Academy of Sciences at St. Petersburg.

In 1744, Dr. Ludolf, at Berlin, had found that by the electric spark sulphuric ether could be ignited; and soon after Professor Winkler, at Leipzig, succeeded in also kindling alcohol, and even common proof spirits.

The experiments excited at the time no small surprise. An account of them, translated from Winkler's description, was, in November of the same year, communicated to the Royal Society of London.

Mr. William Watson, an apothecary, having a shop in Aldersgate Street, who had been since 1741 a Fellow of the Society, undertook to repeat what had been done at Berlin and Leipzig.

He constructed for the purpose a rather rude electrical machine, with glass globes or tubes, to be rubbed against leather cushions, the conductor being sometimes a common poker, sometimes a gun-barrel, suspended by silken cords.

In March 1745, he was able to announce to the Royal Society that he had succeeded in igniting ether and alcohol by sparks drawn from his poker. The Society voted him, before the end of the year, the Copley Medal.

In October of the same year, the Dean of the "Dom capitel" at Kamin, in Pomerania, Prelate Kleist—whom Dr. Lardner erroneously calls a monk at Leyden—had found that the electricity from a conductor could be collected in a glass containing some water, into which a nail had been placed upright; and in the following year it became known that Musschenbroek—quite independently of Kleist's prior discovery—had made flasks for the accumulation of the electric fluid. A wire passed through the cork to the water in a bottle. As this had taken place at Leyden, phials for the accumulation of electricity have since, improperly, and in spite of Kleist's priority, been called Leyden jars.

Hardly had Kleist's and Musschenbroek's bottles become known, when Professor Winkler, at Leipzig, tried the experiment of discharging them through a certain distance of water in the river Pleisse. Dr. P. Le Monnier, at Paris, did the same at considerable distances through the water of a large basin in the garden of the Tuileries.

The apothecary Watson, in London, who had, as we have seen, got a machine made to repeat the ignition of inflammable fluids by sparks from the conductor, also undertook, in 1747, to repeat

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the said experiments made on the Continent, to discharge Leyden flasks through water.

He discharged bottles containing iron filings, instead of water, and being, by the advice of the astronomer, Dr. Bevis (who became subsequently a Member and Foreign Secretary of the Royal Society), externally covered with a thin sheeting of lead, first in London, through the river Thames, near Westminster Bridge, over which, to complete the circuit, a wire was laid, and subsequently out of London, in the so-called New River, near Stoke Newington, through greater distances of water. He also discharged, near Shooter's Hill, Dr. Bevis's jars through nearly two miles of wire, suspended on wooden sticks, the current having to return to the outer covering of the jar through the soil.

Thus William Watson proved that the electric current from a Leyden jar will travel through considerable distances of water as well as earth, and along wires suspended in the open air on sticks; but he never had an idea of applying his experiments to telegraphic purposes.

He wrote in 1746, after having communicated to the Royal Society the results of his first (igniting) experiments: "If it should be asked, to what useful purposes the effects of electricity can be applied, it may be answered, that we are not yet so far advanced in these discoveries as to render them conducive to the service of mankind." He adds, "Future philosophers may deduce from electrical experiments uses extremely beneficial to society in general." Nor did Watson, when in the year following he made the discharging current of electricity from a Leyden jar pass through certain distances of water, wire, and earth, entertain the slightest idea of applying it to telegraphic purposes. But, notwithstanding this, it has been lately stated in print: "Dr. Watson, of England, was the first to propose the construction of an electric telegraph, 1747."

William Watson's favourite study had always been botany; through it he had gained the esteem of Sir Hans Sloane.

In 1749, he visited the locality in South Lambeth, where John Tradescant, the father, in the beginning of the seventeenth century, had established his botanical garden. He was pleased to find some exotic plants still there, that had been introduced by the Tradescants, father and son, who had visited foreign countries. An account of my discovery of the former having visited Russia is given in my "Tradescant der Aeltere, 1618, in Russland."

In 1754 Watson was charged by the Royal Society to communicate to Dr. Lining, in America, who had occupied himself with experiments for conducting lightning from the clouds, some details about Professor Richman's melancholy fate at St. Petersburg. This martyr to science was, as is well known, killed in 1753 by a flash of lightning, whilst looking at the index of the apparatus for observing the atmospheric electricity, which was connected with a conductor placed on the roof of his house.

We see here that William Watson also paid attention to the drawing of sparks from the clouds, as he had done previously from the poker of his electrical machine, but he was not aware of the existence of a telegraphic apparatus worked by frictional electricity, which had been made at Renfrew in Scotland, in the very year in which Richman at St. Petersburg was killed by a flash of lightning.

In 1757, Watson received from the German Universities of Halle and of Wittemberg, diplomas as Doctor. Hence he is, in accounts of his previous electrical experiments, sometimes called Doctor, though at that time he had not that degree. In 1759, he began—rather late—to apply himself to the study of medicine, and in 1760 he was appointed Physician to the Foundling Hospital in London. A year before his death, which took place in 1787, King Gorge III., before whom, as young Prince of Wales, he had experimented with his electrical machine, conferred on him the order of Knighthood, on the occasion of a congratulatory deputation. Thus he died Sir William Watson.

The Christian name of that Watson, who in 1816 died as Bishop of Llandaff (situated in South Wales, not in Ireland, as has been stated at Paris), was Richard. He was born in the year 1737 at Heversham, near Kendal, in Westmoreland.

In 1745—1747, when the apothecary, William Watson, was making his electrical experiments in and near London, Richard was at the place of his birth, a boy frequenting the grammar school, of which his father had been nearly forty years head-master.

Having lost his father in 1753, he was in the following year sent to Trinity College, Cambridge, of which he was elected a Fellow in 1760. He took the degree of Master of Arts in 1762.

In November, 1764, he was elected Professor of Chemistry. He has described this in the following words:—"At the death of Dr. Hadley I was unanimously elected by the Senate, assembled in full congregation, Professor of Chemistry. An eminent physician of London had expressed a wish to succeed Dr. Hadley, but on my signifying to him that it was my intention to read chemical lectures in the University, he declined the contest. At the time this honour was conferred upon me I knew nothing at all of Chemistry, had never read a syllable on the subject, nor seen a single experiment in it."

By great application, Watson was enabled, after about fourteen months, to begin his lectures. Subsequently he wrote several papers, and his "Chemical Essays," in five small volumes, have been more than once reprinted and have been partly translated into German.

In 1769 he was made a Fellow of the Royal Society.

In 1771 he was, on the death of Dr. Rutherforth, elected to the office of Regius Professor of Divinity, although by his own account he seems to have been hardly better prepared for the chair of Divinity than he was for that of Chemistry seven years before.

In 1782 he was made Bishop of Llandaff.

Without mentioning his numerous religious and other publications, nor the sinecures and other lucrative situations given to him, I conclude by stating that, although the brilliant discoveries of Galvani, Volta and Davy were made in his time, and although he survived Soemmerring's invention of the galvano-chemical telegraph by seven years, and Baron Schilling's exploding powder mines by galvanic electricity across the river Neva by four years, he never in the least attended to electricity and electric telegraphy. In his writing the word electricity does not occur a single time. Notwithstanding this, he has just been held out to the British Association for the Advancement of Science, as the person who gave the first idea of an electric telegraph.

Let us hope that a similar assertion will never again be repeated. Bishop Watson's name has no right to appear in the history of the Electric Telegraph.

[We insert with pleasure the above interesting remarks, fully concurring with the indefatigable and venerable author, that such assertions as those made at the Free Trade Hall during the meeting of the British Association at Manchester have been tolerated for too long a period. Not only do we find such incorrect statements put forth, but omissions which we unhesitatingly denounce, not only as invidious, but unjust. Why should the name of William Fothergill Cooke have been omitted by the President in his inaugural address, and by Mr. Grove, a professed electrician? Surely the names of William Fothergill Cooke, John Lewis Ricardo, and Richard Till, the practical founders of our great System of Telegraphy, will shine with no diminished lustre, because a few *savans* have thought proper to ignore their arduous and successful labours in the cause of Telegraphy.—E. E.]

REPORT OF THE TELEGRAPH COMMITTEE

[Continued from page 22.

The next telegraph to which we come is the Red Sea and India Telegraph.

The Red Sea and India Telegraph Company was formed in 1857—58 upon certain concessions obtained by Mr. Lionel Gisborne from the Turkish Government, which authorized a line of telegraph to be

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carried across Egypt and down the Red Sea, thus giving the necessary powers for the construction of a line to India. These concessions give the Company full control over the line, and permit through messages to be forwarded, either in cipher or otherwise, without being subject to examination on the part of the Turkish or Egyptian Governments. It also grants sufficient land for stations, and the necessary connecting land lines. Mr. Lionel Gisborne was the engineer, and Messrs. Newall and Co. contractors, for the projected line. In June, 1858, after two unsuccessful attempts to lay the Atlantic Telegraph had been made, and before the third and successful attempt, the Government gave an unconditional guarantee of 4½ per cent. for 50 years upon the whole capital required for the construction of the Red Sea and India line, viz., £800,000, thus relieving the shareholders from risk in the matter; they appointed an official director who had a general control over the proceedings of the Company.

The cable consisted of a strand of seven copper wires, weighing 180 lbs. per nautical mile, covered with two coats of gutta percha alternated with two coats of Chatterton's compound, weighing 212 lbs. per nautical mile. This core was served with hemp yarn, tarred, weighing 1½ cwt. per nautical mile, protected by iron wires, weighing 16 cwt. per nautical mile. This cable had consequently the largest copper conductor and the best insulation of any cable made up to that date. The whole length of the line is 3,043 nautical miles.

The first portion, between Suez and Aden, was finished on the 28th of May, 1859. It was laid in three sections, exclusive of the land line between Alexandria and Suez. The first section is from Suez to Cossire, 255 nautical miles in length; the second, Cossire to Suakin, 474 miles; the third, from Suakin to Aden, 629 miles in length. The portion of the cable laid between Suakin and Aden tested much less perfectly before it was laid than the other two portions. The section from Suez to Cossire was in good order when laid. There was a fault on the Cossire-Suakin section, 135 miles from Suakin, when first laid, but not such as to prevent the line working, and for several months it did not get worse; the line has, however, since failed.

In February, 1860, the Aden-Suakin section failed, and it was found to have several faults; one appeared to be caused by the gutta percha having been softened by heat, and the yarn having cut into it and bared the copper wire, and there appeared to be a defect caused by the flange of a drum having rolled over the core and cut into the copper wire; apparently before the core had been covered with yarn and wire. The Company endeavoured to repair the section, and laid down for the purpose above 300 miles of new cable. The communication was restored in July. The section, however, failed again five days afterwards. The pieces brought up from this portion of cable showed numerous places where the wire covering was entirely corroded away. In other places, the wires were as good as when first laid. In many places the cable was entirely covered with shells and weeds, and thus protected from corrosion. This section was laid very taut, and some of the injuries have been attributed to tight paying out, but the corrosion of the outer covering would to some extent account for the appearance of the pieces which have been brought up. Faults have also appeared in the Suez-Cossire section.

The second portion of the line, between Aden and Kurrachee, was completed in February, 1860, but remained only for a short time in working order. A portion, of about 70 miles, is laid in depths of from 1,900 to 2,000 fathoms. The sections on this line are, from Aden to Hallain, 718 miles; from Hallain to Muscat, 486 miles; from Muscat to Kurrachee, 481 miles. The Aden-Hallain section has a fault, supposed to be about 230 miles from Aden. The Hallain-Muscat section is stated to be in good working order. The Muscat-Kurachee section has a fault close to Kurrachee, supposed to be caused by injury to the shore end from waves; but it would appear also to have other faults.

The Company have had no means on the spot for the repair of this line, nor have they a staff competent to give the information required to enable the condition of the line to be ascertained with accuracy; but there can be no doubt that, with a moderate expenditure and proper appliances, it would be capable of being made some use of.

It appears that the contract provided that the cable should be maintained in working order for 30 days by the contractor, and that the several separate sections were worked for a longer period; but that the whole was not worked throughout for that period. The speed at which messages could be sent through the longest section, viz., from Aden to Hallain, is stated by Mr. Forde to be about five words per minute, but we believe with proper appliances the line would give a higher speed. We consider that the failure of this line is attributable to the cable having been designed without regard to the conditions of the climate or the character of the bottom of the sea over which it had to be laid; and to the insufficiency of the agreement with the contractor for securing effectual supervision during manufacture and control of the manner of laying. It is, moreover, to be regretted that the contract for laying this line was entered into without a full investigation into the question, considering that the success of the Atlantic cable was at the time very doubtful.

In addition to these lines, various submarine cables have been laid in the Mediterrancan, of these we would specially notice the following:—

In 1854 the Mediterranean Extension Telegraph Company laid down, under concession from the French and Sardinian Governments, a submarine cable with six conducting wires, from Cape Santa Croce, Spezzia, to Cape Corse, in Corsica. From Cape Corse land wires were carried to Bonifacio; from Bonifacio a submarine cable of six conducting wires was laid to Santa Theresa, in the island of Sardinia, whence land wires were laid to Cagliari and Cape Spartivento. From Cape Spartivento a submarine cable was laid in 1855 to Bona in Algeria, a distance of 125 miles.

Mr. Brett made two unsuccessful attempts to lay the latter cable. The first attempt was made with a cable containing six conducting wires, and protected with strong iron wire; it weighed 8 or 9 tons per mile. The vessel in which it was stowed was a sailing vessel, towed, whilst the cable was being laid, by a steamer of small power. More slack was paid out than had been anticipated, and the cable broke during an attempt made to raise it by means of a windlass from deep water.

A cable with three conducting wires, weighing nearly four tons per mile, placed in a steamer, was next attempted to be laid, but it ran short from an error in the course of the ship. The depth at the place was about 400 fathoms, and the steamer held on to the cable for four or five days, whilst buoys and assistance were being fetched by another steamer which accompanied the expedition. Rough weather, however, came on, and the cable broke before the assistance arrived.

Messrs. Newall made the third attempt, and laid a cable with four conducting wires, which weighed three tons per mile. Of the four wires, one appears to have been defective at first, one to have been faulty, and the other two capable of working. This cable has since failed, and it is stated that three faults were found in it; one was apparently caused by corrision and another by coral dredgers, the third is in a depth of 1,200 fathoms, at about 40 miles from the island of Sardinia. The outer covering of the cable was so little corroded that it was able to be picked up in this great depth until within about a mile from this fault; the cable then became very much corroded, and it broke in attempting to raise it, before the fault was reached. The tests appeared to show that the cable was actually broken in this depth, but the cause of this fracture could not, unfortunately, be ascertained. Marine animals and vegetation were found adhering to parts of the cable at the above-mentioned depths. A more careful selection of the route would have enabled the faults which occurred in shallow water to be avoided.

In 1857 the Mediterranean Extension Company, with a guarantee of interest from the English Government so long as the line remained in working order, laid lines from Cagliari to Malta, and from Malta to Corfu. The line consisted of a strand of copper wires, forming one conductor, covered with gutta percha, and protected by a serving of tarred yarn, covered with iron wires. The cable weighed 18 cwt. per mile. The line between Cagliari and Malta remained in good working order for twelve months, when a fault occurred. This fault was repaired, and the line worked again for several weeks, when it again failed in the same locality. An attempt was made to repair this second fault with an extra length of cable, and the cable was raised at some distance from the fault, and the new piece spliced in, put it proved insufficient to reach from the place at which the cable was raised to the fault. The line between Malta and Corfu is laid in depths extending to nearly 2,000 fathoms; it remained in good working order for about a year and three quarters, and then failed suddenly. The exact position of this fault is not known; but it is assumed to be from 20 to 40 miles from Corfu, and is reported as, continuity interrupted, but cable unbroken. The Company have subsequently, in 1859, laid a line from Malta to Sicily, but in comparatively shallow water. This cable contains one stranded copper conductor covered with gutta percha, served with tarred yarn, and protected with iron wires of No. 5½ gauge; it weighs three tons per mile. This line is in good working order.

Mr. Newall has laid lines between the Dardanelles, Syria, Candia, and Athens, and he has three times failed in attempting to lay a line from Candia to Alexandria, where the greatest depth is 1,750 fathoms. In one instance a hemp-covered cable was used and failed in

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laying; it was also found that the teredo had eaten through the hemp and indented the gutta-percha. Mr. Newall states that the hemp covering did not enable the cable to be raised from deep-water.

In the last attempt a portion of the Red Sea cable was used, and after the deepest water had been passed a failure occurred, supposed to arise from a bad joint.

Submarine telegraph lines have been also recently laid between Spain, Majorca, and Minorca by the Spanish Government, manufactured by Mr. Henley, and the French Government have arranged for a direct line between Toulon and Algiers. This line has been manufactured by Messrs. Glass and Elliot. It consists of a strand of copper wire weighing 400 lbs. per mile, covered with four coats of gutta percha alternated with four coats of Chatterton's compound, also weighing 400 lbs. per mile, served with tarred hemp, and protected by steel wires covered with hemp, to prevent their corrosion. The specific gravity of this cable being small, and its strength considerable, it was able to be picked up for some distance in 1,600 fathoms water. The first attempt to lay it failed from a fracture due to the occurrence of a storm when the ship from which the line was being paid out was half-way across; the end was consequently taken into Majorca, and communication established between France and Algeria by way of Spain. A subsequent attempt to complete the line failed from a collision between the vessel sent to assist in laying and the vessel containing the cable.

It will be observed that the failures of all these submarine lines are attributable to defined causes, which might have been guarded against. It is possible that as our experience progresses other causes of failure besides those already ascertained may be discovered, but we believe that there are no difficulties to be encountered in laying submarine cables, and maintaining them when laid, which skill and prudence cannot and will not overcome. Before passing to the next section of our report it will be interesting to describe briefly the arrangements which were made for the manufacture of the submarine cable originally intended to be laid from this country to Gibraltar, subsequently proposed for a line between Rangoon and Singapore, and now about to be laid between Malta and Alexandria.

The manufacture of the core of this cable was contracted for after the complete failure of the Atlantic cable and before the experiment of the Red Sea Telegraph had been decided. The core consists of a strand of 7 copper wires weighing 400 lbs. per nautical mile, covered with three coatings of gutta percha alternated with three coatings of Chatterton's compound also weighing 400 lbs. per nautical mile, to be equal in conductivity and insulation to a previously constructed standard mile. This core is served with hemp saturated in tar, and covered with 18 No. 11 iron wires for the deep-water portion, the shore ends being covered with No. 0 iron wires. The line as originally devised was to have been laid for 300 miles in depths of from 1,500 to 2,500 fathoms, and the covering of this portion was to have been of steel wires, each coated with hemp. When the Gibraltar line was abandoned, the steel and hemp covering was given up, and the iron wire covering was adopted for the whole cable. The core was manufactured at the Gutta Percha Company's Works, and was tested in water in one of Reid's pressure tanks, up to a pressure of 600 lbs. per square inch, the air being exhausted from the tank before the water was turned in. This was the highest pressure to which the tank was adapted at the time; by recent arrangements, however, a much higher pressure can be obtained. The resistance and insulation of each mile of the cable were noted, and a careful system of comparative tests framed, which are to be carried on during laying, and after the cable has been laid, by which means the actual condition of the cable will be ascertained with great accuracy. These tests are described in Appendix No. 11.

The outer covering was manufactured by Messrs. Glass and Elliot. The contract provided that the cable should be kept under water from the time of its manufacture until laid, and that the electrical tests during covering and laying, and afterwards, should be entirely conducted by electricians appointed by the Government or their engineer, to ensure that the comparative tests deemed indispensable should be properly made. The water tanks constructed at the contractors' works leaked very considerably; and in consequence of some misapprehension the ships to carry the cable were not originally fitted with water-tight tanks to hold the cable. The result was, that the cable, at the contractors' works, was alternately wet and dry, and liable to rust; the corrosion of the large surface of iron in the outer covering, coiled in a compact mass, occupying a small space, rapidly generated heat, which could only be kept down by pumping water over the cable, in the absence of any means of permanent submergence. As long as this water was at a low temperature, so as to prevent the heat in the cable rising to above 50° Fahrenheit, no great mischief could result, as oxidation would not progress rapidly; but when the temperature of the cable increased beyond that amount the heating occurred in an accelerating ratio, reaching a mean of 86° Fahrenheit. This effect of wetting the iron covering of a cable had not previously been experienced, but it has a very important bearing on the selection of the form of outer covering of a cable. If the line had been laid in one length from Falmouth to Gibraltar, it was estimated that about five words per minute would have been passed through it; if, however, it should be laid in three sections between Malta and Alexandria, the speed at which it can be worked would be materially increased.

(*To be continued.*)

ON A NEW FORM OF GAS BATTERY.

BY W. SYMONS.*

The ingenious and original arrangement known as Grove's Gas Battery, although always looked upon as an instrument of great philosophical interest, appears to have been little used as an instrument of research and experiment, except in investigations on the combinations of various gases. I have long thought that a modification of it may be usefully employed in many experiments requiring a weak but continuous current, and I believe the following arrangement will be found convenient and economical, as it brings into active operation a far greater amount of the platinum used, and may be easily constructed by students and experimentalists who, like myself, are thrown entirely on their own resources and manipulation for the construction of their apparatus.

FIG. 1.

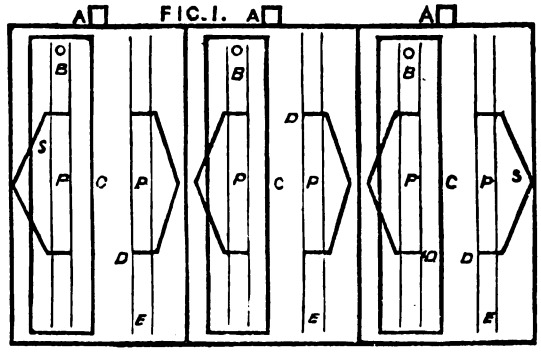

Fig. 1 is a plan, and fig. 2 a section, of three pairs. The tray is made of gutta percha, about one inch deep; it is divided into water-tight compartments, about 2½ inches wide; the length of the tray will depend on the number of cells required, and its breadth on the length of the platinum plates used. A gutta-percha tube is fixed on the bottom to communicate with a reservoir of hydrogen. *A* are small projecting tubes to keep the liquid at a uniform level. *B* are tubes perforated through the bottom of the tray and standing above the level of the acid, to admit a constant supply of hydrogen from below. *C* are cells about one inch deep, ¾ inch broad, and long enough to cover the platinum strips. These are best composed of glass, but may be made with thin gutta percha with glass on the top. *P* are the platinum plates, ½ inch wide, doubled lengthways into a U shape, and divided in the middle through a part of their length. The connexions *S* are silver wires twisted together in the middle, passed through the platinum, and attached to the latter at *D* by a blow-pipe: it would economize room were the platinum creased into short zig-zags. The battery, as here described, supposes the use of hydrogen and the atmosphere, but it may be easily constructed for two gases by the addition of tubes at *E* similar to *B*, for the supply of oxygen from below.

The advantages of this arrangement over Grove's, I think, are cheapness of construction, the absence of connections by binding screws or mercury, the facility for removing the plates to clean, &c., and, above all, the great economy of platinum; for whereas, in Grove's, a platinum plate, for instance 4 inches long and ½ inch broad, would, according to his theory of its action, only have one inch of active surface—in this arrangement it would have sixteen times that amount.

I may be allowed, perhaps, to add a suggestion with regard to

* Read before the British Association at Glasgow, 1855.

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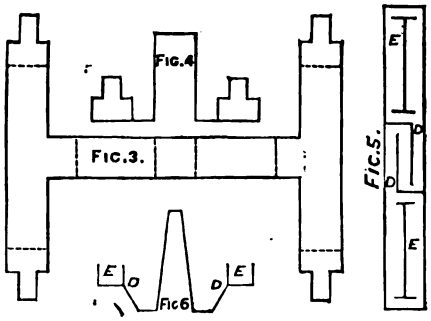
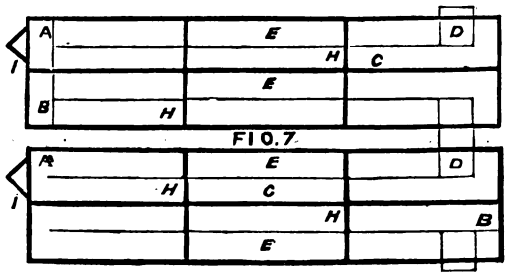
apparatus of a totally different kind, such as the condensers, multipliers, &c., used in static electricity where a perfectly smooth conducting surface is required, as in the apparatus described yesterday by Professor W. Thomson. I believe plate glass gilded is generally used. The substitute I would suggest is common slate—it is much cheaper, far more easily worked, polished, and gilded; perhaps rubbing it over with good plumbago would render it a sufficiently good conductor. This is the plan I have adopted in an electroscope described in the *Chemist* for August. It may also be an advantage, in some cases, that as a conductor it would be free from specific induction.

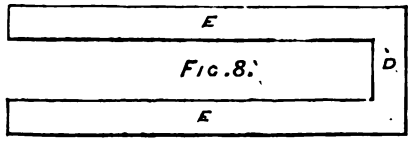
P.S.—In the following arrangements the necessity of joining two metals is dispensed with, as both the positive and negative plates for adjoining cells are cut from one piece of metal. The first plan can be used with the tray and cells *C*, as described above; and the only disadvantages are using a little more platinum, and a little more difficulty in removing the plates to clean, &c. One pair of plates on this plan were shown in connection with the above paper, made of platinized silver; but I have found the silver foil is liable to melt when heated in a spirit lamp to render it perfectly clean. Fig. 3 is cut out of thin gutta percha, and bent at the dotted lines so as to take the shape of fig. 4. Fig. 5 is a strip of platinum, not shown so long in proportion as it would be required, cut as represented by the lines, the middle can then be drawn out, and considerably lengthened—this is merely to economise platinum; it is then to be bent as shown in fig. 6, and placed on fig. 4.



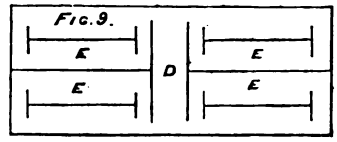
In the following arrangement, *A B*, fig. 7 are plans of two gutta percha cells, 1½ inches broad,



about the same depth, and any convenient length. The partition *C*, in the middle of each, does not reach to the bottom by a quarter of an inch. The division *A* of each cell has a glass cover, which slides into a groove like the cover of a small paint box; with a little care this may be made so close that when the glass is wet it will be air-tight. At *D*, a small piece must be cut out exactly level with the bottom of the glass cover. *E D* is the platinum. Fig. 8 shows its shape. In



the cells the parts *E E* are placed perpendicular, supported by moveable pieces of gutta percha, *H*. It will be perceived the piece cut out of the cell at *D* is to admit the connecting piece of platinum under the glass. *I I* are attached to the cells to admit tubes for supplying hydrogen, and to keep the liquid at a uniform level. This description supposes that the division *B* of each cell is left open, receiving its supply of oxygen from the atmosphere; but of course it can be closed in the same manner as *A*, and pure oxygen supplied. To keep the battery in action, a gutta percha tube can be used as a main in connexion with a supply of hydrogen, and in this tube small glass tubes fixed to communicate with the cells through *I*. Another shape for the plates has suggested itself to me, but I have not yet tried it. Fig. 9 shows the platinum as cut. Fig. 10, an end view of the same,



as bent for use, the letters *D E* showing the same parts in the two figures. By this arrangement there will be two surfaces of platinum in each division of the cells. The cut *D* must in this case of course be in the middle, and not at the end of the cell.

I believe either of these plans will be equally effective, and the constructor will probably be guided by the economical use of the platinum foil in his possession; but the first plan will be found the most economical and convenient in practice. Possibly the silver may be corroded by the acid, especially should it not be pure; but I have not found it the case, although I have kept the battery in action for forty hours together, and also had the same plates immersed nearly as long in acid more than three times the strength of that used in the battery. Should this, however, be the case, the silver could be replaced by gold.

EARTH CURRENTS.—No. 3.

[Continued from p. 17.]

In order to enable our readers more fully to comprehend the nature and action of the phenonema of earth currents, magnetic storms, &c., the following extracts from the evidence given before the Government Committee upon submarine telegraphs, by practical electricians and telegraphists, will afford a considerable amount of interesting and useful information.

Mr. C. V. Walker, F.R.S., in his evidence, remarks: "There seems to be little doubt that a large wire will be more affected than a small wire by magnetic storms." Further, in the report of his mission to Keyham, *Minutes of Evidence*, page 102, Mr. Walker adds, "Should the cable (the Atlantic cable) be laid in its integrity, there are certain cosmical conditions to which it will be exposed that promise to be of serious inconvenience. I mean the variation in terrestrial magnetism, and especially those variations known as magnetic storms, and which are now increasing in number and force, and will doubtless follow the recognised cycle, and steadily increase during the coming two years or so." * * * "Doubts were afterwards expressed to me, whether this influence would be felt on submerged wires. These doubts, however, have been removed by the results of the observations made at Valencia on the 380 miles of cable lost there. The effect of these disturbances are felt by me in their fullest development on the line of telegraph from Ashford to Margate, places occupying somewhat the same relative positions as Valencia and Newfoundland. Coincident with the earthquake at Naples in December last, we had our needles so violently deflected as to become horizontal at one time. The disturbance continued with greater or less violence, and with continual variations, for 36 hours. During my absence at Keyham on April 9th, we felt the effect of a still greater storm than the above. I have it noted as the most violent on record. During some part of the time, we could not send messages on the instruments in their then condition. In 1848–9, when these disturbances were least at their height, we met the minor difficulties by a mechanical arrangement, but in the heavier cases we condemned one of our needles, and used its wire as a return wire for the one remaining needle *in place of the earth. By this device the disturbing action of one wire was neutralized, as far as the telegraphic instrument was concerned, by the reverse action of the other wire, while both led to the earth. With earth wires removed, the line wires were free from disturbing influencee.* I have long considered that your only protection against these disturbances will be to have two wires instead of one; to have, that is a *complete metallic circuit*, returning by a second wire, instead of being discharged to the earth."

The next witness who adverts to the phenomena of earth currents is Mr. W. H. Preece, Engineer to the Channel Island Telegraph Company. In answer to question 2786, Mr. Preece states:—"I have endeavoured to trace the existence of currents produced by running water, which Wollaston wrote about; but I can see nothing of the sort. There are always delicate earth currents in the wires at every period of the day, or at any time of the night, whether land or submarine wires;

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but it is only when the aurora borealis is visible that we find any serious effect arising from those earth currents." * * * "I have examined them at all hours of the day; I cannot trace any particular law by which they are guided. There is a steady current in one direction in the morning, and generally in the other direction in the evening; there is one time of the day, about twelve or one I think, when, generally speaking, the wires are perfectly neutral; but the strongest time of the earth currents is generally early in the morning, and about six in the afternoon; they are generally equal about those times." * * * "We find, invariably, a connection between 'earth currents,' and magnetic storms, generally commencing and ending at the same time." * * * "There are lines which are called 'neutral lines' that never are affected at all by earth currents; supposing there are earth currents to-day, observable on a wire running north and south, and say that the earth current upon that wire running north and south, gives a deflection of 20°, an earth current running north-west and south-east, will perhaps give a current of 10°; but when we go to-morrow, we shall find it just the reverse, when a line running between them has perhaps not been affected at all; we find that wires coming east and west have rarely earth currents."

Still following the evidence, Mr. Fleeming Jenkin describes a singular phenomena under the designation of a "false discharge," which he attributes to the mutual action of adjacent coils of the coiled cable (under experiment), and would not at all be observed in a straight line. Professor Wheatstone, however, demurs to this conclusion, and attributes the cause to the polarization of the earth plates. We quote the Professor's own words (see Appendix, p. 288). "The cause of these effects is the polarization of the plates or masses of metal connecting the ends of the wires with the earth. The first effect is produced by the polarization of the terminal which connects the telegraphic wire with the earth, the second by the polarization of the terminal which connects the galvanometer with the earth. When the wire is sufficiently large for the discharge current from it to affect the galvanometer, the first effect is a complex one, the discharge current being added to the current of polarizaton. The electro-motive forces of the currents arising from polarization, can never exceed that of one or two cells of a voltaic battery, and as the strength of these currents diminishes with the length of the wire, they are not observable in long telegraphic lines, unless very delicate instruments be employed."

Mr. Jenkin further observes with regard to line currents (see p. 147): "The disturbing influence of line currents alone limits the diminution of battery power. These line currents will not, I think, exist to any serious extent in a sound cable, or in a cable with small faults, unless, perhaps, during electrical storms."

The next witness is Mr. Cromwell Varley, who furnishes some very interesting information, the result of his practical knowledge and experience in the working of the extensive lines of the International and Electric Telegraph Company. Mr. Varley's statements are as follows (see Appendix, p. 151): "In long submarine lines we are very much bothered at certain periods by the earth currents. There are currents continually flowing about the earth either in one direction or the other throughout the day. These currents seem to reach a maximum somewhere about 2·40 P.M. They are evidently connected with the rotation of the earth on its axis, and I will draw attention to a curious coincidence or analogy between them and the tides. The moon goes round the earth once in about twenty-nine days; the earth rotates once in twenty-four hours; the tide reaches its maximum about three days after new moon or full moon; these currents reach their maximum (not three hours), but two hours and forty minutes after noon and after midnight. They are rather stronger, I think, at noon than at midnight. They agree with the magnetical variations recorded at Greenwich, and are doubtless in intimate connection with them."

We shall continue our extracts in the next number. In the mean time we trust that the above instructive statements and suggestions will be the means of directing the attention of telegraphists and others to the subject. In all probability the restoration of public confidence in the practicability of ocean telegraphy, will, in a short time, result in the establishment of a wide and comprehensive system, and all efforts to render the system efficient and permanent, will not fail to gain the unfeigned approbation of all those who value progress and civilization. Any means by which the effect of earth currents might be avoided would be of no small benefit to those who have the working of our overland wires, but would prove of immense value in future submarine lines of great extent.

(To be continued.)

Colonial and Foreign Telegraphy.

REPORT OF THE GENERAL SUPERINTENDENT OF ELECTRIC TELEGRAPHS IN THE COLONY OF VICTORIA.

To The Hon. The Postmaster-General.

Department of Electric Telegraphy,
Office of the General Superintendent,
Melbourne, 21st January, 1861.

At the date of my concluding Report for the year 1859, the several extensions of lines and works in active progress during that year, had been completed, and opened for communication. The short line from Maryborough to Creswick, *viâ* Back Creek and Clunes, was opened with Back Creek on the 21st ultimo, and will probably be opened with Clunes on or about the 5th proximo; this line would have been opened at a much earlier date but for the delay occasioned through there being no provision for stations at the time of its completion, (the vote having been previously exhausted).

The line to Cape Schanck is still unopened owing to a decision communicated to me by the Honorable the Postmaster-General, in the month of July last, apprising me that no further charges on account of the work alluded to, could be incurred until such time as it might be required for actual use, either in time of war, or by the settlement of inhabitants in the vicinity. On further consideration of the matter at a more recent date, it was, however, eventually decided that communication should be opened with Snapper Point and Cape Schanck, and offices at those localities are in course of erection. Communication will be available, I hope, by the middle of February.

The short extension from Dunolly to Tarnagulla (Sandy Creek), was opened on the 1st November last, but the decease of the late manager at Tarnagulla, occasioned a temporary interruption to the business of the office, which was not fairly opened until the 18th November, since which date the communication has been regularly maintained.

The branch line extending from Beechworth, and connecting with Yackandandah, Chiltern (Indigo), and Wahgunyah, was completed on the 1st ultimo, but owing to the limited amount available under the vote for stations, it has been found that the erection of permanent structures must be deferred until after the estimates for 1861 may have been voted; in the meantime temporary wooden buildings are now being provided, and the communication will probably be made available during the ensuing month.

The line from Portland to Hamilton was reported completed on the 15th ultimo, but from their being no funds for the erection of the requisite station building, it will be necessary to make some provisional arrangements for opening the communication; these I hope to complete, and to have the line available within about six weeks.

Lines proposed for Construction in 1861.

The extensions contemplated during the ensuing year are considerably reduced from my original recommendation, owing to the general reductions now being effected in nearly every branch of governmental expenditure.

Provision has been made upon the estimates for the erection of a second or *through* wire between the eastern and western boundaries of the colony for facilitating the intercolonial business. The requisite amount has also been introduced for providing an extension between Ararat and Pleasant Creek, and for effecting alterations and improvements generally to existing lines. The necessity for the provision of the second wire is specially alluded to in the seventh page of my last report, and in now reiterating the remarks made therein, I can only express my regret that the necessary amount could not have been availed of at an earlier period, as I am fully convinced from personal observation, that had this facility been in existence during the past year, the revenue of the department would have shown an increase of nearly £1,500 over the amount actually received. In other words, the absence of the provision alluded to has occasioned a loss to the service amounting to about the sum I have named, during the year 1860.

I was desirous of securing the extension of a line to Sale and Port Albert, Gipps Land, and also the extension of the Sandy Creek line Swan Hill, on the Murray, during the present year, but I was informed that the exigencies of the public service would not admit of the necessary provision (15,500) being made during 1861. I therefore did not press my proposition, further then to give expression to the opinion I still hold, that the extensions alluded to might be rendered self-supporting, or in any case, that they would form no permanent charge on the resources of the government, beyond the first cost for establishment, &c.

Tasmania (intercolonial) Communication.

I regret to have to report that since the 28th of April last, the sub-

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marine section of this line, between Sea Elephant Bay, King Island, and West Bay, Three Hummock Island (49 miles), has been interrupted. The damage is of an extensive nature, and has been found to exist at a point about eight to ten miles south-east of Sea Elephant Bay. Full details connected with the attempted repair of the cable will be found in the Report of the Superintendent of the submarine line, together with full particulars relative to the same subject, contained in the documents annexed to this Report (Appendix A).

Subsequent to the date of my Report of the 13th September, 1860, the Honourable the Treasurer for Tasmania visited this colony on behalf of the government of Tasmania, in order to negociate as to further proceedings respecting the repair of the line; when it was determined, that as it was inadvisable, under existing circumstances, to incur the expense of engaging a steamer, the most suitable sailing vessel for the work, available at this port should be procured, and duly despatched with the requisite equipment of men, boats, grappling lines, spare cables, &c.; this decision was carried into effect, and the party, under the charge of the superintendent, started in the schooner "Tommy," 59 tons, on the 11th ultimo, provided with such lengths of spare cable as could be rendered available (in all about five miles), with the view of raising and re-connecting the several ends of the cable; but, although the expedition has succeeded, notwithstanding the unusual prevalence of inclement and unseasonable weather recently experienced, in weighing and buoying the inner end of the broken portion, about seven miles from the landing, the attempt to recover the outer end of the cable has up to the present period proved unsuccessful. Every effort is now being made, as I am assured by telegraphic reports from Mr. Savage, to discover and raise the sea end of the cable, but the constant recurrence of unfavourable weather greatly retards operations, which, under less adverse circumstances, would, ere this, I have no doubt, have been attended with success.

The remaining sections of the line continue to test perfectly, and for all practical purposes are now in a thoroughly efficient condition; communication is maintained with Cape Otway and King Island on the one hand, and between Launceston and Circular Head on the other; the line between the latter point and West Bay, Three Hummock Island, being still in efficient order, although of course unemployed pending the repair of the broken section seaward of West Bay.

The line was laid down in four sections in preference to adopting the more direct route from Heads to Heads, with the express view of affording to the Governments interested a greater insurance against total loss in carrying out, what, under any circumstances, could only be considered as a really hazardous undertaking. It may eventually become a matter for the consideration of the Governments of Victoria and Tasmania, whether, in case of the present attempt to remove the existing interruption being unsuccessful, it would not be advisable to relay the entire single section between King Island and Three Hummock Island; afterwards recovering so much of the original portion of cable as might be rendered available for future repairs, &c. The cost of effecting the renewal alluded to would not exceed £10,000, or £5,000 for either colony; and as the remaining sections of the line continue in a condition of entire integrity, after an expenditure upon the whole work of more than £53,000, I consider that strong arguments could be adduced to warrant the additional expenditure, if found to be necessary, for re-establishing and perfecting the communication between Tasmania and Victoria.

(To be continued.)

TELEGRAPH TO THE PACIFIC.

[From a New York Paper.]

WERE not the public mind engrossed by the terrible scenes of war, we should stand in awe and wonder at the completion of a chain of telegraphs to the Pacific. It is scarce twelve years since the tide of emigration began to flow towards our Western coast. Then California was a very remote region, and the dwellers on the Pacific slope seemed as far away as the inhabitants of Peru. Well do we remember the triumph, when by a railway across the Isthmus of Panama, and by more rapid steamers, San Francisco was brought within three weeks of New York. It is but within a year that the enterprise of a telegraph to the Pacific has been resolutely undertaken and pushed forward with vigour, and now behold, the work is done! The line, thus completed, is the longest in the world. Taken with its Eastern connections, it reaches from St. John's in Newfoundland, through the British Provinces, and across the whole broad Continent—a distance of five thousand miles!

Imagination is tasked in embracing such immense distances, and in following the flight of winged messengers from ocean to ocean. Swift as thought the message flies over mountain and lake and river, across the vast, arid plains, and over the crests of the Rocky Mountains, till the voices of affection, whispered here by the Atlantic, are heard mingling with the murmurs of the Pacific.

It is easy to speculate on the commercial and political consequences of this great achievement. More than ever it makes us one nation. The children of New England and of the Middle States, transported to the Western Sea (that never forgot their father's house before), now feel their affection quickened into new life at these hourly messages from home. The feeling of one country thrills the hearts of millions from the Atlantic to the Pacific.

Nor is this to be the end. The skill of man that has traversed the continent, will yet conquer the sea. The path of the lightning, which traverses such immense distances on land, will not be checked by the barrier of the ocean. We have now before us a despatch from Sacramento, dated on Friday, Oct. 25, which reached here at half-past two the next morning. It was addressed by the Chief Justice of California to his brother, Cyrus W. Field, of this city, and after general congratulations on the success of this undertaking, adds: "Our rejoicing may recall the rejoicing which was producing by the laying of the Atlantic Cable. At some future day I am confident Europe and America will yet speak to each other through the sea."

Such is our faith—a faith unshaken by past disasters—and to this end science steadily marches forward. It is but a few weeks since that a submarine cable was laid from Malta to Alexandria, a length of 1,300 miles—an achievement in which its undertakers have such confidence, that by their contract with the British Government they guarantee, not only that it shall be laid successfully, but *kept in working order for seven years*. If it can thus traverse the Mediterranean, may it not span the Atlantic? We believe that not only Europe and America will thus be united, but also Asia and Africa and Australia; and that in a few years messages from India and China, swifter than the light, will yet pass over the whole breadth of Asia and Europe, and of the Atlantic Ocean, and be diffused over the whole Western Hemisphere — even before the sun tinges the Eastern horizon.

SILVER'S INDIA-RUBBER INSULATOR. — "We think Silver's India-rubber Insulator for overland wires well worthy of the attention of our authorities, and hope our men of business will not be slow to recognize the value of these private telegraphs, which are so cheaply made and so easily worked when their method of insulation and system of reading is adopted. Any man with a moderate amount of business, both in London and America, is now using his own private wire between his counting-house and manufactory, or between his own office and that of any other person with whom he is in constant intercourse; *and we think it would be well if Mr. M'Gowan in his next estimate for telegraphic extension, would recommend a sufficient sum to enable him to connect all the public offices in Melbourne with these wires, by way of setting an example to our merchants, and proving their utility.* We are quite sure that the saving in sending messages by porters, or even by post, would more than pay the Government the cost of such a connection of the public offices; and it cannot be questioned that with such a ready means of communication at command, a large amount of correspondence would be saved."—*Colonial Mining Journal.*

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.—Very little inquiry throughout the week, but the holders are firm.

	s.	d.
Fine genuine	1	6
Good ditto	1	3
Good reboiled	0	10
Inferior ditto	0	7

INDIA RUBBER.—The demand has been very limited during the week a very few tons of the low qualities have been disposed of, such as Assam, 9¾d. to 10¼d., and the low Penang at 9d. per pound. The useful and approved descriptions, prices remain very firm.

	s.	d.	s.	d.
Para—First quality	1	7	to 1	8
„ Second quality	1	3	to 1	5
Negro	0	11		
Fine Java and Penang	1	3	to 1	3½

November 22nd, 1861. W. KIRKMAN.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do. B. 7 per cent. till 1862	all	18 to 20	———
20	Do. C. „ „	all	9 to 11	———
Stock	Electric Telegraph . .	100	95 to 98	97 and 6½
20	Red Sea and India Telegraph	all	19 to 19¼	———
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	———
1	Do. registered . . .	all	3/8 to 5/8	———
10	Do. „	all	4 to 6	———
5	United Kingdom Telegraph	2	½d. par.	———

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Correspondence.

INSULATING MATERIALS.

To the Editor of THE ELECTRICIAN.

SIR,—It appears that several specimens of insulating materials were submitted to experimental test under the direction of the late Telegraph Committee of the Board of Trade. Those experiments are fully described in the appendix to the report, and possess considerable interest to telegraphists and others interested in the successful development of subterranean and ocean telegraphy. I have carefully examined the result of the said tests, and must confess that I cannot agree with the conclusions arrived at by the committee, as embodied in their report. It appears to me that sufficient attention has not been paid to the numerous and important facts determined by the tests. Statements occur in the report which are inadequately supported by the voluminous evidence, or the elaborate experiments. The following is a list of the various specimens of covered copper wires subjected to test, with the names of the patentees or manufacturers.

Designation of Wire.	Diameter of Copper.	Thickness of Covering.
GUTTA PERCHA COMPANY.—Copper wire covered with plain gutta percha	7/32	3/32
Do. do.	8/32	6/32
Do. do.	4/32	6/32
Do. do.	7/32	12/32
Do. do.	8/32	6/32
GUTTA PERCHA ALTERNATE COATINGS.—Copper wire covered with 10 coatings of gutta percha and 10 of Chatterton's compound	7/32	6/32
GUTTA PERCHA SPECIAL.—Or improved copper wire covered with improved material	8/32	3/32
Do. do. covered with alternate coatings of improved material and compound	7/32	3/32
Do. do.	8/32	6/32
HUGHES'.—Copper wire coated with gutta percha, and a viscid semi-fluid substance introduced between it and the next coating of gutta percha	7/32	6/32
SILVER and Co., B.—Copper wire covered with india rubber	8/32	4·2/32
Do. C. do.	8/32	6·2/32
HALL and WELLS, A.—Copper wire covered with cotton thread and india rubber	8/32	3/32
Do. B. do.	8/32	3/32
WRAY'S.—Copper wire covered with Wray's compound	7/32	6/32
RADCLYFFES' A.—Copper wire covered with gutta percha passed through a certain chemical process for increasing its durability	8/32	6/32
Do. B. do.	8/32	6/32
GODEFROY'S.—Copper wire covered with patent cocoa-nut gutta percha	8/32	3/32
HEARDER's, 440 yards.—Copper wire covered with gutta percha	1/32	6/32

The first five covered wires were ordered, I believe, by the committee with the view of determining the laws which govern the induction on insulated wires of various dimensions, especially when subjected to increased temperatures, as well as to determine the effect upon the insulation of such wires when so subjected to high temperatures.

These wires were coated with plain gutta percha, meaning, I presume, the ordinary material with which telegraphic wires were coated at the time.

The first two wires are capable of being compared with those coated with new or improved materials, such as "special gutta percha," Silver and Co., and Hall and Wells' "india rubber," "Wray's compound," and Radclyffe's carbonized material; also with Hughes and Hearder's new mode of application of the dielectic. ALED.

A NEW AND SIMPLE METHOD OF CHARGING A PELTIER ELECTROMETER.

THE difficulty of imparting from an electrophorus a determined charge to a Peltier Electrometer has long been felt. Mr. Owen Rowland adopts the following plan: To the vertical brass stem of the instrument a spiral of very fine silk covered copper wire is attached. By exciting a small piece of ebonite or sealing wax, by gently passing it over a piece of dry silk or any portion of the dress, and then presenting it to the loose end of the spiral wire, a powerful charge will be instantly imparted to the stem. To reduce the tension to any given degree, a piece of metal is attached to the electric used for charging the instrument, capable of absorbing by each contact with the stem a given portion of the charge. This plan will be found extremely useful in testing the insulating powers of various materials. The ends of the spiral wire should be well rounded, to prevent escape of electricity by sharp points.

Law Intelligence.

ROLLS' COURT, Nov. 19.

(Before the MASTER of the ROLLS.)

THE ATTORNEY-GENERAL V. THE UNITED KINGDOM ELECTRIC TELEGRAPH COMPANY (LIMITED).

This case, which was before the Court on a previous occasion, when an interlocutory injunction was asked for on behalf of Baron Lionel Rothschild, M.P., now came on upon a motion for a decree. The baron, at whose instance this information has been filed, against the above-named company, and the Commissioners of the Metropolis turnpike roads north of the Thames, is the owner in fee simple of certain lands in the parish of Acton, Middlesex, abutting upon the south side of the highway between Tyburn and Uxbridge, which is under the management of the said commissioners. The telegraph committee, which, with a nominal capital of £150,000, was established for working and maintaining telegraphic communications between various places in Great Britain and Ireland, and for carrying out the telegraphic system of Thomas Allan, obtained the sanction of the Turnpike Commissioners to construct a telegraph along the road between Tyburn and Uxbridge; and along that part of the road adjoining the baron's property (and of the half of that part of the road next to his property he claims ownership), the telegraph company claimed the right, under the sanction given to them by the Turnpike Commissioners, to lay down their telegraphic apparatus. The baron insists that the commissioners were not entitled to give that sanction. It appears that the telegraph company claims to have parliamentary powers for laying down their lines of communication by virtue of an Act which was obtained in 1851 by an abortive company. The informant alleges that, by pretending to have parliamentary powers, the present company have succeeded in several instances in obtaining the consent of landowners to construct telegraphic lines. The case was only partially opened when the Court rose.

The Solicitor-General, Mr. Selwyn, and Mr. Pooks were counsel for the plaintiff; Sir Hugh Cairns, Mr. Follett, Mr. Chitty, and Mr. Bentinck were counsel for the defendants.

November 20th.

The opening of this case was resumed. On behalf of the public, the Attorney-General complained that the posts which the company have erected along various highways for the support of their telegraphic wires are public nuisances; and Baron Lionel Rothschild, M.P., who was joined as a plaintiff with the Attorney-General, complained that the company, with the sanction of the Commissioners of Turnpike Roads north of the Thames—but which sanction he alleged that they were not entitled to give—had encroached upon his right to the half of that part of the highway between Tyburn and Uxbridge, which adjoins his land at Acton, by their telegraphic operations.

The Solicitor-General and Mr. Fooks having been heard for the plaintiffs,

His Honour, without hearing the defence of the company or of the commissioners (for whom Sir H. Cairns, Mr. Chitty, and Mr. Bentinck, were counsel), said he was clearly of opinion that the question whether or not Baron Rothschild had any property on the highway adjoining his estate was a legal question. He was not at all satisfied that he could come to the conclusion that the posts which had been erected by the company were public nuisances. No doubt some persons had stated that the posts were very considerable obstructions and inconveniences, but he anticipated that for the defence many persons were prepared to affirm that they were not so. The question whether or not the posts were public obstructions was a question for a jury. He was therefore of opinion, that he could not properly dispose of this case until the legal right had been ascertained. That was the view which he took of the case when it came before him upon an interlocutory application. It was necessary to keep quite distinct the two questions which had been raised—that which had been raised by the information, and that which had been raised by the bill. That which had been raised by the information was, whether the company's constructions were public nuisances. That question ought to be tried in a court of law in such manner as the Attorney-General should think fit. That which had been raised by the bill, namely, the trespass complained of by Baron Rothschild, must be tried by an action at law. The Court was not prepared to say that the bill should be at once dismissed. That was a question which ought to depend upon the result of the proceedings at law. The bill would therefore be retained until the result of the proceedings at law were known, if there should be any proceedings.

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Miscellanea.

MALTA AND ALEXANDRIA CABLE.—We understand that Mr. G. E. Preece, late Superintendent of the Submarine department of the Electric and International Telegraph Company, has been appointed engineer and electrician to this undertaking.

THE allotment of shares in the Telegraph to India Company will take place on the 21st instant. The order for the cable, and for the charter of the vessel, will be issued at once, and the steamer will be speedily despatched with the staff and line.

IT is stated that all the messages sent from England by the Malta and Alexandria cable to catch the India mail which left Marseilles on the 6th instant, were duly received in time for transmission by that steamer. The line is said to continue to work well, and the traffic is daily increasing.

MEDITERRANEAN TELEGRAPHS.—We are informed that a convention has been signed with the Italian Government allowing English clerks to be placed in all the principal telegraph-offices throughout Italy, whereby it is hoped the irregularities hitherto existing will be obviated. We hear it is intended to maintain a telegraph steamer constantly in the Mediterranean, for the speedy repair of any injury that may occur to the Malta and Alexandria cable, and that this vessel when not otherwise engaged, will be employed carrying mails, goods, and passengers between the different stations, and possibly between this island and Corfu, if the Government will contribute a subsidy to assist in defraying the expense. The obvious advantage to the Government of maintaining steam communication between two such important garrisons and naval stations as Malta and Corfu, leads us to hope that it will not lose so favourable an opportunity of obtaining this desideratum, which would at the same time be of great service in promoting the commercial and social relations of the two islands. We understand it has been decided to replace the present land lines of the Malta and Alexandria telegraph at Benghazi, now erected on Poles, by a portion of the submarine cable, which is to be laid underground for greater security against accident, either from the weather or mischievously inclined persons. This cable is to be conveyed to Benghazi in a sailing vessel, and laid as soon as possible. Messrs. Glass, Elliott, and Co.'s telegraph steamer Berwick left again on Friday last for Marsala and Cagliari on her way back to England.—*Malta Times.*

DAMMARA RESIN.—There are two varieties of this substance known in commerce. The first is a light yellow resin resembling copal, said to be derived from the *Pinus dammara*, or *dammara alba*, of India. It consists of a resin, the greater portion of which is soluble in alcohol. It forms a fine varnish with oil of turpentine. The second is also called Cowdie, or Kaurie resin. It is the product of the Dammara Australis, of New Zealand. Cowdie resin is extensively used in America as a varnish. In colour it is of a darker yellow than the former variety.

ELECTRICITY.—In a memoir translated in the *Bibliotheque de Geneve* M H. Buff considers the analogy of the sources of the electricity of friction and contact, and gives as the result of numerous experiments his opinion that contact of heterogeneous substances is the cause of the former. This conclusion is combated by the editor, M. A. de la Rive, who does not consider it to be fairly derived from the facts related. He considers that the experiments of the generation of electricity by pressure, from which M. Buff derives one of his principal arguments in favour of the contact theory, seems rather to prove that the origin of the electricity is much more related to the molecular movements, which arise as much from pressure as from rubbing; since, according to the nature of these movements, it is sometimes the positive, sometimes the negative fluid with which the two rubbed or pressed substances are charged.

THE following observations on some of the disturbing influences upon telegraphic wires, due to atmospheric causes, are taken from Noad's Manual of Electricity; a most useful and complete work, which every student of this science should possess:—"The natural state of the telegraph wire may be disturbed without the presence of a thunder cloud, by the passage of currents of electricity from one portion of space to another; the electrical condition of the atmosphere surrounding the wire being different from that at another. A difference of elevation will do this, as kite experiments abundantly testify, so that if the line of the telegraph passes over an elevated mountain ridge, there will be continually, even during clear weather, a current from the more elevated, to the lower points of the conductor; vapour, fogs, snow, and rain at one end of the wire, and not at the other, may likewise determine currents of electricity of sufficient power to set the marking machine of the telegraph in action. The natural electricity of the telegraph wire may even be disturbed by the induction of a distant cloud moving first towards, and then from the wire, though such currents would be feeble.

IN the telegraph wires from Vienna to Somering, an atmospheric current is constantly observed in the direction from the first to the last mentioned town during the day, and in the contrary direction at night. The change of direction takes place after the rising and the setting of the sun.

BREAD AN ANTIDOTE TO THE EFFECT OF MUSTARD.—The odour of bread is popularly supposed to remedy the effects produced by mustard, when the latter has been taken in too great amount. The proof which is commonly offered in support of this notion affords an amusing example of an illogical conclusion from an observed fact. By the act of smelling bread, the burning sensation produced by the condiment is certainly alleviated; and the conclusion which has been drawn from this is to the effect that bread affords an antidote to the irritant oil contained in the mustard. This, however, is not the case; the benefit received through the olfactory process being due to the current of air which removes the volatile oil from the delicate membranes in which the palate terminates. The effect would be equally produced by smelling at any other substance. But at table, a person aware of the benefit of inspiring a current of cold air, would recommend to children or others, who might happen to take an overdose of mustard, the act of smelling *bread*, (being a substance invariably at hand,) as a palliative to the burning sensation. And thus bread, like many other substances, as well as persons, would obtain by equivocation an undeserved reputation for qualities it does not possess.

A FLYING MATCH ACROSS THE THAMES.—In the year 1855, when the telegraph wires which now cross the river Thames, in proximity to Blackfriars Bridge, were being suspended, a ludricous case of disappointed expectation occurred. The wires were attached to two elevated buildings on either side of the river, and were being gradually raised to their present altitude. The novelty of this operation attracted a considerable crowd upon the bridge. In answer to a curious inquirer as to the purport of the wires, a waggish policeman informed some of the spectators that preparations were being made for a flying match across the Thames, to take place at seven o'clock, between an Irishman and an Objibbeway Indian. This intelligence, imparted in a confidential tone, had its effect, and at the appointed hour the bridge and its approaches were thronged by a considerable number of Arabs, young and old, from the neighbouring courts and alleys. By this time the policeman had been replaced on his beat by another, ignorant of the joke, as well as of the real use of the wires, and who consequently could offer but little explanation. Being myself entirely engaged in carrying out the operations, I was repeatedly asked when the match was to commence; but the question being incomprehensible to me, and sounding very like what is vulgarly termed "chaff," I maintained a dignified silence. At length I ventured to ask one of my questioners what he meant. "Why," said he, "the match atween the Hirishman and the Hinjun." I assured him I knew of no such piece of competition, and briefly explained that the wires were for the purpose of an electric telegraph. He then called out to a "partner," "Bill, the gen'lman says it's an 'oax, and that them's only the telegraft wires!" Very shortly afterwards the whole of the disappointed wonder-seekers dispersed.

To Correspondents.

SUBSCRIBER.—In reply to our correspondent's request to be informed of the cheapest, simplest, and best adapted instrument for private telegraphs. We shall cause an inquiry to be made into the subject, and communicate the result.

C. P.—The report of the Joint Committee appointed by the Lords of the Committee of the Privy Council for Trade, and the Atlantic Telegraph Company, to inquire into the construction of Submarine Telegraph Cables, is to be had of Messrs. Eyre and Spottiswood, Her Majesty's printers, New Street Square, Fleet Street. Price £1.

Meteorological changes, as influenced by electro and magnetic phenomena, offers a wide and interesting field for investigation. Every facility will be afforded to those interested, to discuss the subject in our columns.

We also particularly invite the attention of those electricians who have the opportunity of observing the effect of earth currents, magnetic manifestations, &c., upon the telegraphic lines in their respective districts, and to transmit the same to us for early publication.

J. W. STEARS, Hull.—We shall avail ourselves of the information whenever an occasion may occur.

"A SUBSCRIBER."—*Gum Dammar.*—The New Zealand Kaurie (Dammara Australia) is the source of the Dammara, resin gum Dammara. Gum Kaurie is a true gum. As met with in commerce it is mixed with a large amount of impurities. Digested in alcohol it leaves a considerable portion of insoluble matter, principally extractive, and earthy impurities; the latter does not appear to be intentionally added, but it becomes impregnated with these foreign matters from the peculiar manner in which this resin is collected. It exudes spontaneously from the tree, and allowed to indurate without having the dirt, &c., removed from it. If it should promise to become an article of commercial importance, the best and only means of providing it sufficiently pure would be to strain it as it flows from the tree, before allowing it to harden.

W. H. H., Haverfordwest.—Your suggestion relating to the advertisement sheets will be adopted.

W. SYMONS.—Why not use *ebonite* for the battery trays, as you find so much difficulty in obtaining those made of glass? We insert the paper on your arrangements for the gas battery, which may probably now receive the attention of practical men.

J. R. BROADLANDS.—We propose giving shortly a series of elementary articles on electrical science, which may afford to the uninitiated a key to our general observations upon telegraphic matters. We intend the latter to be in all cases sufficiently simple and intelligible to be readily understood by all who have mastered the first rudiments of electricity. Noad's Manual of Electricity gives a good introduction to the subject you refer to.

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The Electrician.

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ELEMENTARY ELECTRICAL SCIENCE.

A PORTION of our columns is this week devoted to the requirements of those who are commencing the study of the useful and interesting science which gives the title of this journal. The wishes of several correspondents have anticipated our intention to afford such elementary information and instructions as are needed to form the basis of the acquirements of the student in electricity. The foundation of a science is often indeed the most difficult part of the structure of knowledge;—when we are isolated from the help of kindred workers in nature's great *arcana*, and dependent upon books, which perforce must leave many things untold. We remember the difficulties, the discouragement, the occasional disgust, we experienced in attempting to verify the problems of electrical science with inadequate means for their solution. It is easy to understand that men who have passed through these should not always be inclined to "fight their battles o'er again," for the benefit of the tyro. But those who undertake to give the groundwork of a science have often much to answer for in the way of bewildering and confusing their readers by illogical sequence, inaccurate diction, and defective arrangement. When they are so unreasonable as to require us to run before we have learnt to walk, it is not surprising that we should stumble at every step. We may remark that of late years the facilities for obtaining definite ideas on the subject of electrical phenonema have greatly increased. Sciences generally become simplified as they advance, albeit in some branches they may attenuate into the abstruse. In electricity there is seldom any absolute need of mathematical or other abstractions; and although the use of *formulæ* may in some instances be a convenience, they may for all practical purposes be dispensed with.

A certain amount of difficulty in the pursuit of science is calculated to increase our interest and forward our proficiency. There is oftentimes more to be learnt by a failure than there could be by success. For this reason we would advise the student at the outset to construct his own apparatus, and contrive his own instruments; in order to obtain a thorough practical knowledge of the same. The man whose constructive faculties are constantly active, has an immense advantage over those who are dependent upon others for the materials of experiments. We say nothing of the question of comparative expense; but in many cases the apparatus which is contrived and perfected by the student's own endeavours, is incomparably more perfect and adapted for his use than any he could purchase. With wood, gutta-percha, tin-foil, metal in sheets, glass tubing, and shellac, almost every variety of electrical apparatus may readily be constructed in its most perfect form. When a knowledge of what is required in these instruments has been obtained, and not till then, valuable time, and labour no longer valuable, may be spared by having recourse to the philosophical instrument maker. We have invariably observed that a profusion of expensive instruments in what should be the simple laboratory of the student is of bad augury both for his past and his future progress. But, on the other hand, after passing through a certain stage of experience, his time may undoubtedly be better employed than in winding a galvanometer coil, or coating a Leyden jar.

We do not premise our course of familiar instruction to the student by the enunciation of the elementary principles of electrical science. To begin at the beginning is doubtless in all cases an excellent maxim; but in the natural course of observation we do not at once arrive at the origin of things. We reason *à posteriori* as well as *à priori*. We would, moreover, rather incur the charge of being desultory in our instructions, than we would fail in imparting some degree of interest to them. Our own experience of a student's difficulties and requirements will perhaps form our best guide in addressing those we would wish to forward in this branch of knowledge.

HEAT AND LIGHT FROM DECOMPOSED WATER.

ONE of the most interesting problems of chemistry, in a practical point of view, is the economical decomposition of water for the purpose of utilising its hydrogen as a source of heat. It is of importance that the conditions under which this decomposition is to be effected should be well understood. As commonly obtained in the laboratory, hydrogen gas is obviously of less value for a practical application than the materials from which it is evolved. When, for instance, the vapour of water is passed over iron nails, or filings, contained in a porcelain tube heated to redness;—by far the most economical of the ordinary methods of producing the gas,—the iron consumed or reconverted into its ore represents an amount of heat, employed in the process of smelting, far greater than that which would be evolved by the combustion of hydrogen in atmospheric air. The reduction, by means of carbon, of the oxide of iron obtained, could not therefore be profitably included in the operations for producing the gas as a fuel. It is probable also that all the methods which have been suggested for obtaining hydrogen by the action of muriatic acid upon a metal, are liable to a similar objection.

When the vapour of water is passed into a furnace, as proposed by Messrs. MAIRE and VOLLER, the decomposition of the water in the first instance abstracts from the fuel exactly the same equivalent of heat as would be produced by the combustion of its elements. On the other hand this heat is again given out in the subsequent combinations of the gases, which are also the source of a considerable amount of surplus heat. Thus, the hydrogen unites with carbon, and the elements of the resulting compound combine with the oxygen of atmospheric air present in the furnace; while the oxygen combines with two equivalents of carbon to form carbonic oxide, which, by a further accession of oxygen, becomes carbonic acid. The process is therefore theoretically perfect, and the water is profitably consumed as a fuel within the furnace.

By a modification of this plan, in which the heated fuel is contained in a close vessel, the combustible gases may be generated and collected in a receiver. It has been found, however, that a considerable amount of carbonic acid is thus produced. This might doubtless be remedied by increasing the heat of the fuel within the vessel or retort.

As a source of heat or of light obtained by heating platinum or lime, carbonic oxide is greatly inferior to hydrogen gas. To obtain the latter gas in a state of comparative purity, we have tried the following method with favourable results:—

A mixture of sesquioxide of iron and powdered coke is placed in an iron tube passed through a small furnace, and heated to redness. One end of this tube is connected with a vessel containing water, and heated with a spirit lamp for the production of steam. The other end of the tube communicates with the gas-holder through a Woolf's bottle containing milk of lime, and furnished with a safety-tube. The steam, when passed through the tube, is decomposed by the charcoal; hydrogen and carbonic oxide

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being evolved. The latter decomposes the oxide of iron, reducing the metal, and becoming converted into carbonic acid, which is subsequently absorbed by the lime water. But the metallic iron becomes again oxidized by the steam, with the evolution of a further portion of hydrogen. Thus, while the necessary degree of heat is maintained, a copious supply of nearly pure hydrogen is generated in the apparatus. In this process a considerable accession of heat is obtained in the formation of the carbonic acid. In repeating this experiment, care should be taken by the student to avoid, by a careful adjustment of the safety tube, the effects of a sudden condensation of steam.

This, or a similar process, might probably be economically adopted for the production of fuel from water. By igniting platinum foil in the hydrogen flame a pure white light is obtained, which, moreover, would have the merit of extreme cheapness.

The impure gas obtained by passing steam over heated coke has been utilised in the manufacture of ordinary illuminating gas. The water gas is conducted into the retort in which gas is being produced either from coal or resin. From what appears to be a prejudice on the part of the gas companies, this process has never been adopted to any considerable extent. Its advantages are thus summed up by Messrs. Abel and Bloxham*:—1. The olefiant gas and vapour of hydrocarbons are rapidly removed from the retort by the current of water gas, and are, therefore, not exposed to a temperature sufficiently high to decompose them, as is generally the case. 2. The aqueous vapour appears to be decomposed on coming into contact at an elevated temperature with the tarry hydrocarbons, in such a manner as to convert their carbon into carbonic oxide, and to liberate the hydrogen, which advantageously replaces a part of the light carburetted hydrogen in ordinary gas. 3. The carbonic acid produced in the first retort is reduced in the second to carbonic oxide, by contact with the carbonaceous matter at a high temperature. 4. That certain coals which generally yield a gas burning with a smoky flame, from a superabundance of carbon, may be made to furnish a gas sufficiently diluted for illuminating purposes.

Review.

TELEGRAPHIE ELECTRIQUE. By J. Gavarret.

[Continued from page 23.]

The second chapter of the present work is devoted to the description of various telegraph instruments, most of which are well known in this country, and have been described in Col. Shaffner's Manuel. The dial instrument of Brégnet is that which is in general use for short circuits in France; the Morse instrument being principally employed for long lines. The advantage possessed by the latter of permanently recording every signal transmitted, causes it to be preferred by the *Administration des Telegraphes;* while, upon the lines of railway, the facility with which intelligence can be forwarded by the *employés* through the dial instrument, without any previous training, is duly appreciated. The modification of the Morse instrument used in France is known as that of M. M. Digney; the points and dashes being marked in ink, instead of simply impressed upon the paper.

The introduction of the beautiful instrument of Professor Hughes is still under consideration by the French telegraph authoties, the objections to its immediate adoption being merely of the most prudential character.

The alarum and signal contrivances for railway use described by M. Gavarret, are of special interest. That which has been proposed by M. M. Bianchi and Lejeune, to obviate the collision of trains proceeding in opposite directions upon a single line of rails, is very ingenious and complete, but appears to remedy an evil which should never be allowed to exist. The plan suggested by M. Guyard to allow a signal of danger to be received by a train in motion, and also to indicate the proximity of two trains upon the line, and thus prevent their collision, appears to be somewhat unnecessarily complicated for practical use, but contains all the elements of a very perfect system for the prevention of railway accidents. This arrangement is as follows:—

In a direction parallel to the line of rails are disposed *two* metallic wires insulated from the earth, (*one* would appear to suffice) divided into sections about 1,600 *mètres* in length, in such a manner that the interruptions in one wire correspond with the middle of the other sections of wire. The locomotive of each train carries a small battery arrangement, the negative pole of which is connected with the earth through the wheels of the locomotive and the rails. The positive pole of the battery is in constant connection with the insulated wires by means of a spring arrangement. The locomotive also carries an alarum bell apparatus placed in the battery circuit. It will be seen that this circuit is not completed until one of the insulated wires is brought into contact with the earth.*

Supposing that a signal of danger upon any point of the line is to be given to an approaching train, the insulated wires at this point are severed, and the extremities placed to the earth, or the earth contact may be made at the ends of any of the sections of wire. The positive pole of the battery of the approaching train is, therefore, in connection with the earth the moment it comes into contact with the broken wire; and, the negative pole being already in connection with the earth, the current is thus completed, and the detent of the alarum withdrawn by an electro-magnet.

M. Guyard proposes to use a commutator, moved by clockwork, to reverse at short intervals of time the contacts of the locomotive battery with the rails and the insulated wires. Thus, supposing two trains to be in dangerous proximity to each other, the circuit between the two batteries would be completed by the wire through the two alarum instruments, and a warning given to the drivers of each locomotive. But as trains are seldom allowed to run in opposite directions upon the same line of rails, it would appear sufficient to connect alternately with the earth the positive and negative poles of the batteries of succeeding trains, to avoid collision through the breakdown of an engine or by the backing of a train.

To avoid the dangerous consequences of one or more carriages becoming detached from a train, it has been proposed to connect the poles of a battery on the locomotive with two wires passing the whole length of the train, and united at their extremities. An alarum, also on the locomotive, is placed in circuit, and sounds when the circuit is broken. The wires, being attached to each of the carriages, are broken when one or more of these become detached, and this occurrence is notified to the engine driver by the sounding of the alarum.

The problem of establishing a communication between two trains travelling upon the same line of rails, and also between the trains and the telegraph stations along the line, is stated by M. Gavarret to have been solved by M. Bonelli, whose system was satisfactorily tested upon some of the Sardinian lines, though it has not hitherto been adopted in practice.

(*To be continued.*)

* "Abel and Bloxham's Hand-book of Chemistry."

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 31.]

II.

The Construction and Laying of Submarine Cables.

A submarine cable consists generally of some insulated conductor, strengthened and protected by other surrounding materials to preserve it from injury, as well during the process of submerging it, as after it is laid at the bottom of the ocean.

The whole subject of submarine telegraphy may be yet said to be in its infancy, and all that has been done has been rather the result of bold, though successful tentative processes, than of the application of any well ascertained data to the ends to be obtained. Under these circumstances the success which has attended many of these operations

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is a proof of the practical skill of the few talented individuals who have devoted their attention to the subject, and their advice and co-operation have been of the greatest value to the Committee in directing attention to their requirements.

The early history of submarine telegraphy resembles in a most striking manner the progress of land telegraphs, in which, as the requirements have arisen, such remarkable progress has been made; and there is no reason to doubt but that a similarly successful result will ultimately attend this new branch of the subject.

The early telegraphs began within the limits of a railway station, and almost insuperable difficulties attended their construction for a distance of even twenty miles. A further extension necessitated an entire change in the whole process. The wires, covered with cotton saturated with a solution of caoutchouc, and laid in metal tubes, were entirely abandoned, and the open air telegraph was adopted; but even with this improvement it was several years before it was found possible, even in fine weather, to work with certainty over a greater distance than 100 miles. Whereas, so perfect has the system of insulation now become, that no difficulty is experienced in communicating directly and instantaneously between London and any part of Great Britain.

It was unreasonable to expect that the progress of submarine telegraphy should be in any degree more rapid, and we ought rather to be surprised at the gigantic strides it has already made, than to be disheartened by the difficulties that have been experienced in the undertakings that have been attempted. It is a remarkable fact, and, as regards the science of the subject probably an unfortunate one, that complete success attended the laying of the first telegraph cables. They became successful precedents to appeal to; further investigation was thought unnecessary, and with no variation as regards the prinples of construction, cable after cable was designed and laid down under circumstances and conditions having no resemblance to those originally encountered. The result was, however, far more encouraging than might have been expected. It is indeed, doubtful, whether the transmission of messages for even so short a period through such a cable across the whole width of the Atlantic be not a result worth all the expenditure that has been incurred.

Down to the date of our investigation, about fifty cables had been already laid down, and Appendix No. 18 contains a list of the cables, with the date of laying down, the particulars of the number of wires, the distance traversed, the company or government to whom they belong, their present condition, and in cases of failure, the causes of their failure, and the accidents to which they have been found liable.

In all these cables the same general principles prevail, viz.:—

1. The central conductor is a copper wire or strand of wires.
2. The insulating covering is gutta percha.
3. The external protection, when used, consists of hemp, or other fibrous material, impregnated with pitch or some other resinous substance, nearly in all cases covered with iron or steel wire, in the form of an ordinary twisted rope.
4. The cables so prepared have been paid out over the stern of ordinary vessels with a pressure break, to regulate the delivery according to the speed of the vessel, which has averaged from four to six knots per hour.

It will be convenient to retain these subdivisions in detailing the results that have been arrived at, briefly stating under each head the state of the subject at the commencement of the investigation.

1. *The Conducting Wire.*

The material used for this purpose has in all cases been copper. Its durability and its high conducting power render it peculiarly applicable to the purpose. It was originally used for land telegraphs, but its want of tensile strength, and especially its value to marauders, renders it inapplicable for open air lines; and though it is a far better conductor than iron wire, the extra size necessary when iron is used, is rather an advantage than otherwise, when the exposed situation of such work is considered; the conducting power of pure copper is to that of iron as one to eight, so that a copper wire 1-10th inch diameter is equivalent as an electrical conductor to an iron wire nearly 1-3rd inch diameter.

In the first telegraphs the conductor consisted generally of a No. 16 copper wire. This size gave abundant area, and the resistances, even when used in lengths of several miles, were not found to interfere seriously with the working. The conducting power of copper wire was taken to be directly as the area; there were, however, no precise data for determining *à priori* the size of wire requisite for any given length of circuit and speed of transmission. The wire was joined by being carefully lapped and soldered at the joint, and wrapped with smaller binding wire, which was also soldered with silver solder. The utmost care was necessary in the construction of these joints, and a large number of faults originated in their imperfection, and, indeed, the joint was always much more brittle than the wire itself, and liable to fracture, and a break at any single joint destroyed the value of a whole cable. Moreover, copper could not be procured of homogeneous texture, and not only did hard and soft places occur, but defects, or the presence of foreign matter frequently rendered the wire so weak that it ultimately parted after being covered, thus entirely destroying the circuit by the separation of the broken ends in the elastic material with which it is surrounded. In other cases the defect, without causing fracture, reduced the area of the wire at these spots. It was also found that if a wire covered with gutta percha be excessively stretched, the copper wire on contraction was apt to knuckle through the covering of gutta percha, arising from the copper wire being capable of permanent extension, while the elastic covering of gutta percha regained its original dimensions.

To remedy these frequent cases of fracture, bundles of smaller wires of similar area in the aggregate were adopted instead of a single copper wire. When the conductor is thus formed of a number of wires, the joints in the several wires are distributed; and the fracture or defect of a single wire does not therefore vitiate the whole cable; but it is objected to this arrangement, that on the failure of any single wire the sharp fine broken end is liable to start out through the gutta percha, and then come into contact with the outer covering, or the water or damp earth on which the cable is laid, a defect not easily detected, and which can only be guarded against by close examination of the strand itself, and by the constant testing of the gutta percha covering of the wire during its manufacture. It is also evident that in the form of a strand the bulk of the conductor is greater than with a single wire, and more gutta percha is required to obtain the same thickness of covering.

Want of solidity is urged as an objection to the strand form of conductor, *i. e.*, it is alleged that if water penetrates in any place to the wire it will pass along the wire as in a tube; the Gutta Percha Company propose to remove this objection by coating the central wire of the strand with Chatterton's compound, and bedding the six outer wires in it in the process of twisting. The compound, which passes out between the interstices of the wires, becomes firmly united to the first coating of insulating material, and the whole is so solid that a few inches of this strand will prevent the percolation of water at a pressure of 600lbs. per square inch. Mr. Daft proposes to obtain the same object by bedding copper wires coated with brass in vulcanized india rubber. Mr. Clark has proposed to obtain this solidity by making the conductor in the shape of a solid wire, divided into three or four sections longitudinally, fitting closely to each other. Mr. Newall unites the several wires of a strand with solder.

To prevent the injury to one wire of a strand conductor from damaging the whole conducting capacity of the cable, Mr. Varley proposes to insulate separately what would otherwise be the several wires of a strand conductor, and to unite them at intervals, and use them as one conductor. For instance, assume that the cable's conductor has three conducting wires, each surrounded with gutta percha; these three would be connected together at frequent intervals, as follows:—First, Nos. 1 and 2 would be connected together by soldering or otherwise; a little further on Nos. 2 and 3 would be connected, and further on still Nos. 1 and 3 are so joined, and so on, the different metallic junctions breaking joint, and no two of them being in the same spot. Excepting at these junctions, the separate conducting wires would be isolated from each other. Now, if the insulating covering were damaged, water would enter, and the wire become defective, strong positive currents could be applied to the cable, which would eat away the conductor till its exposed ends retire inside the insulating envelope, these parts would then offer so much resistance that the line would be workable again. Thus a cable may be injured in several different places and yet be made available.

In the first telegraph wire that was made, the strength and toughness of the gutta percha was increased by combining it with sulphur, and this was thought to increase also its insulating properties; but the sulphur was found to act seriously on the copper, a sulphuret being formed at the expense of the copper. In the use of this wire it was discovered that in cases where the wire had parted in the interior of the sulphurized gutta percha, and the two ends had become slightly separated, the resistance offered by the lining of sulphuret of copper, produced on the passage of a galvanic current sufficient increase of temperature to ignite the gutta percha, and actually burst out into flame. So certain was this action, that charges of gunpowder were specially prepared by this means for submarine explosions and other such pur-

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poses; and this method possesses very important advantages from the smaller area of conducting wire that is necessary in comparison with the area requisite for the distant ignition of platinum for such purposes.

(To be continued.)

EARTH CURRENTS.—No. 4.

[Continued from p. 33.]

We continue our extracts at full length. Being the result of practical experience in the working of long lines of Telegraphs, our readers will be better able to judge of the correctness of the conclusions generally arrived at by the witnesses when compared with our own observations, when hereafter detailed in the columns of the ELECTRICIAN.

MR. CROMWELL VARLEY'S evidence—*(continued)*:

Do you think the temperature has anything to do with earth currents? I can offer at present no very distinct clue as to their cause; but I expect it has to do with the temperature, and is connected, I imagine, with the expansion of the atmosphere removing, as it were by expansion, the oxygen from the surface of the earth, so disturbing the magnetism in the earth. I imagine that that may be the cause, but this is little more than a conjecture; the sun probably radiates more forces than are at present known to us.

Have you kept any accurate register of the observations of earth currents, or reduced them to curves at any time? No, it is impossible to do it with telegraphic lines; the currents on such lines are so weak, and the amount of current that we get by induction and leakage from one line to another is so great in proportion to the daily currents, that it is impossible to record them accurately, added to that, our lines are seldom free enough, or those who could take the observation, free enough to take them. The only way to take the earth currents, is by establishing, at the different observatories, lines on purpose. I have communicated with Professor Airy on the subject, and pointed out to him the means by which, on wires a mile, or even half-a-mile in length, distinct records of earth currents could be obtained. The second source of disturbance is a very serious one, that is from what are sometimes termed magnetic storms. When magnetic storms are observed at Greenwich, or the aurora borealis is about, we invariably have very powerful currents, flowing sometimes in one direction and sometimes in another along the wires. Generally speaking these currents change from positive to negative very rapidly, sometimes in the space of a small fraction of a second, but more generally in half-a-minute or a minute, and sometimes longer.

When you say flowing through wires, do you mean a cable? Through conductors of any description, whether over-ground or underground. I should mention that we are never able to devote very much time to the observation of these "magnetic storms," owing to having to exert ourselves to the utmost to get the Company's business through when the storm temporally ceases, and to making such arrangements as will neutralize as much as possible their mischievous effects. The plan which I adopt, whenever we are able to do so, is to take off the earth from one line and substitute a return wire for the earth, when the currents which are generated in one wire neutralize those generated in the other, and we can work them without any material obstruction. But as the insulation of no two wires is exactly alike, we shall have currents, only to a much less extent. I have collected a great many facts connected with these currents, more with respect to the direction of them in different parts of England, and find that there is no general line across England for them. The line from London to Ipswich is very powerfully affected; the lines from Hull to Leeds, and Leeds to Manchester, are lines powerfully affected; the line from London to King's Lynn is a line that is very frequently almost neutral; while going still further north, take the line from London to Newcastle, these currents flow in the same direction as those through the London and Ipswich circuit, which is on the other side or south of the London to King's Lynn line, which is nearly neutral. This shows that the neutral line, or the line of equal electric tension, is a curved one. I have traced out some of these currents, and they seem to be influenced by the configuration of the Island. It would seem that the soil is a less good conductor than the ocean, and that the currents that are flowing through the ocean upon coming to the land meet with a check; and the very powerful currents observed on the short lines—London and Ipswich, Liverpool and Leeds, Liverpool and Hull, and Manchester and Leeds—are partly due to the indented form of the coast at Ipswich, Liverpool, and Hull.

Is the line from London to Bristol affected by earth currents? The line from London to Bristol is very frequently powerfully affected; but it is also frequently a neutral line, showing almost no disturbance. The line from Portsmouth to Southampton is very frequently neutral. I will give some diagrams, showing the direction of the currents at different times, which will do more than any verbal explanation I can give. These earth currents, or "magnetic storms," caused serious inconvenience last year, and on one day caused considerable excitement at the Stock Exchange, the telegraph communications being almost suspended. During the last autumn, I succeeded in measuring some of the currents between London and Ipswich, and had to introduce an opposing battery of 140 cells of Daniell's battery to balance the current, showing, therefore, in the earth at Ipswich, compared with the earth at London, a difference of electric tension amounting to 140 cells of Daniell's battery. Taking this line, roughly speaking, at 60 miles, and assuming that the same state of tension existed all the way across the Atlantic, for a cable of 2,000 miles you would have a current of great power flowing through that line, equal to from 4,000 to 5,000 cells of Daniell's battery, which force would be extremely dangerous, and might destroy the insulation of such a line; but on comparing the currents received in London from Ipswich, with those received from Amsterdam viâ Ipswich, I found that the latter were, comparatively speaking, but little stronger than those received from Ipswich, and that a return wire between London and Ipswich was nearly sufficient to neutralize the effects of the "magnetic storms." I therefore think, that in the ocean itself, the tension is very much lower than what we experience on land, and on that account, the fears that I first entertained as to the durability of an Atlantic cable on account of these earth currents, are almost entirely allayed.

Mr. LATIMER CLARK'S evidence:

Have you noticed the effect of what are called false currents in coiled submarine cables? Yes, very frequently; the effect is very apparent in cables coiled in small diameters. I have seen it in a coil of 20 feet diameter; but it is not at all apparent in large coils; nor do I think it a phenomenon of any importance in telegraphy, except while experimenting before the cables are laid down. It is the result of the action of one coil upon another, as originally pointed out by Faraday. It is very easily shown on small coils; but I think it is of no importance. The cause of these currents has already been accounted for in our last letter.

Have you made experiments on the effect of earth currents in working through telegraph lines? I have very often witnessed them, and have taken much interest in them. I have devised a machine for the purpose of balancing that force, and counteracting the effects. The machine consists of any ordinary magnet, or needle, which is surrounded by coils of thick wire in connection with a single cell of battery. A handle moves horizontally upon a table, and when that handle is in a central position it makes no contact with the cell at all; when it moves to the right hand it causes this cell to work through the thick wire coil in one direction, and when it is moved to the left hand, it causes it to work through the thick wire coil in the other direction. If you move it further and further to the right hand, or to the left hand, it throws into circuit a gradually increasing resistance coil, so that when it is worked to the extreme right it allows the current to work through the thick wire on short circuit, or when it is moved to the extreme left, it allows the current to work on short circuit; when brought nearer and nearer to the central position the current has very little resistance from the small wire. In that manner you get the means of truly balancing the changing force of earth currents as they rise. I have noticed some extraordinarily violent effects at different times from earth currents; but they have never been so excessive as they were during 1859. We have even had them at such a pitch of intensity that they caused visible sparks to pop between the terminals when touched.

Have you applied this instrument? Not yet, but I have one ready.

What is the strength of earth currents compared with battery power? I have never myself been able to measure one that would overpower a stronger battery than one of 36 cells; but Mr. Varley has measured one as high as 70 cells; and on the occasion I speak of when visible sparks occurred, which they did abundantly, both in this country and on the continent, the tension must have been equal to the power of many hundreds of cells.

Is the weather peculiar in which earth currents are observed?—They are invariably accompanied by the aurora borealis. I have not traced out any law concerning them, but I have made preparations for measuring their intensity by the use of a Peltier electrometer the next time they occur.

Is there any peculiar season of the year when they are observable? Only so far as they depend upon the aurora borealis.

Are earth-currents uniform in their direction, or is there any general law concerning their direction?—I can trace no law as to their direction; at times they are most powerful East and West, at other times

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North and South; in five minutes they frequently change their direction to the right or to the left.

The 28th of August was the great day on which almost all telegraphs were stopped, not only in Europe, as far as Rome and Naples, but also in Australia?—Yes.

I believe a short line which goes from the House of Lords was never affected?—I have seen numberless instances of a line two miles in length being powerfully affected by these currents. On the occasion of which you have spoken, the short lines under the streets of London were powerfully affected by these currents.

Are the North and South lines affected more than East and West lines?—No, one storm will have its direction North and South, and another East and West.

The inspector of the French Telegraph says that their lines were much more affected East and West: but that does not appear to hold good in this country?—No; I have urged on the Astronomer Royal the importance of the Government laying two or three wires radiating from the Royal Observatory, with copper-plates at each end. I have pointed out that three wires will virtually give six points of the compass, four wires will give eight points, and by combining their effects you will get sixteen points of the compass. I believe, on a line of 10 or 12 miles the effects of earth-currents would be visible daily. I think that many of the effects that are now observed by means of a suspended magnet are really due to the passage of these currents. I have frequently written to Professor Airey, to tell him that we had violent deflections of our needle, and he has invariably replied that he also has had violent deflections of his magnet.

(To be continued.)

Colonial and Foreign Telegraphy.

REPORT OF THE GENERAL SUPERINTENDENT OF ELECTRIC TELEGRAPHS IN THE COLONY OF VICTORIA.

[Continued from page 34.]

We reserve for our next impression the account of an interesting experimental inquiry by Mr. McGowan, to test the qualities of the various forms of pole insulators commonly used. The following, which concludes the report made by this gentleman, affords valuable details respecting the progress of electro-telegraphy in Australia.—E. E.

Lines in other Colonies.

I am in receipt of two highly interesting reports by Charles Todd, Esq., Astronomical Observer and Superintendent of Telegraphs in South Australia, one dated 16th March, on the general advancement and condition of the department in that colony to the 31st December, 1859; the other, dated July the 10th, on the estimated cost of erecting a line of telegraph to King George's Sound. With regard to the first, I learn that the extensions of lines in South Australia are still progressing, and that the department is fully self-supporting, although the depressing influence of the present dullness in mercantile affairs has apparently been felt there as well as in this colony. Mr. Todd's report on the King George's Sound route, proposes an overland line *viâ* Port Augusta and Fowler's Bay, and he estimates the cost at £50 per mile. I fully concur with him in the feasibility of his proposition, but I am under the impression that it would be necessary to carry out working operations for the construction of the line, at least west of Fowler's Bay, almost entirely by sea, as the absence of fresh water along the route would be a serious obstacle to the success of a permanent land party, more particularly if much difficulty were to be encountered, as is not improbable would be the case, in procuring suitable timber for posts.

The King George's Sound connection would, of course, be primarily beneficial to South Australia, under almost any circumstances, but particularly during the continuance of the existing postal arrangements with England; and there can be no doubt that a connection would eventually be extended to Freemantle, thus forming a complete system of inter-communication by electric telegraph between Queensland and Western Australia, embracing the whole of the colonies at present in existence on the main continent of Australia. That such a result may be attained at no distant date is sincerely to be desired by every well wisher of his adopted country, and that it will positively be attained, sooner or later, I have the fullest confidence.

I am in receipt of a very detailed and valuable (4th) report by Captain Martindale, R.E., lately Under Secretary for Public Works, and Commissioner for Internal Communication in New South Wales. In the section of his report devoted to the electric telegraph the following statement occurs:—"The total expenditure upon lines opened to 30th June, 1860, was £41,338 14s. 6d.; the cash receipts, £5,836 4s. 7d. for the half year; the working expenses £3,567 11s. 6d., and the net receipts £2,268 13s. 1d.; giving a dividend of nearly 5½ per cent. for the half year after payment of working expenses. The returns of the last half year show a considerable increase in the number and value of messages transmitted, although several of the stations were opened late in the half year. This increase would no doubt have been larger, but for the general commercial depression and stagnation in trade. The telegraph receipts were also sensibly diminished by the interruptions to the working of the lines, arising from the unprecedented floods of this year, and the unfortunate failure of the Tasmanian cable." In another portion of his report Captain Martindale observes:—"It is impossible not to be struck with the large proportion, both in number and value, which messages on the public service bear to private messages in Victoria, as compared with South Australia and this colony. In the former they are not paid for, in the two latter they are" I may remark, that I feel the full force of the last observation, and as I have already pressed the subject upon your attention, I would now beg to remind you that I am still waiting your direction in the matter.

Captain Martindale also justly remarks in concluding his valuable Report:—"As railways and the electric telegraph extend, it may be hoped that private enterprise will undertake at any rate their management. Meantime it appears inevitable that the Government should bear the burden of the early years of such works in a new country, and labour amidst difficulties and complaints, satisfied with seeing real advancement made." I need scarcely say I fully concur in the views above expressed.

Communication with England *viâ* India.

Since the departure for England of Mr. Francis Gisborne (with reference to whose propositions I have already had the honor of reporting specially) I am not aware that any positive or practical progress has been made towards the consummation of the well matured project submitted to and approved by the Legislative Assembly in the month of May last (*vide* extract of proceedings in appendix C hereto); the untoward failure of the Aden and Kurachee line having of course seriously interfered to interrupt the proposed extension from India *viâ* Java to Australia, and the several failures of other deep sea lines tending in a great measure to retard at least for the present any immediate action relative to the Australian connection, I fear the chances of a satisfactory development of Mr. Gisborne's proposition are exceedingly remote, more especially when it is remembered, that according to last accounts the cable between Singapore and Batavia had proved almost a total loss; I cherish the hope however that much time will not have elapsed ere some new and improved method of preparing submarine conductors will have been devised, more fully adapted to meet the various conditions to which all sea lines are in a greater or lesser degree invariably subjected. Until such a desideratum may have been satisfactorily attained, I do not look forward with certainty to any considerable extension of submarine communication likely to affect Australia in a favourable degree.

In the meantime, I believe that the nearest approach to Great Britain and Europe through the electric telegraph will be found by establishing telegraphic communication with King George's Sound.

I have the honour to be, Sir, Your obedient servant,

S. W. McGOWAN.

The Hon. The Postmaster-General.

DETERMINATION OF THE AMOUNT OF SULPHUR CONTAINED IN PYRITES AND OTHER COMPOUNDS.

At the late meeting of the Manchester Literary and Philisophical Society Dr. Crace Calvert stated that he wished to draw the attention of the manufacturing chemists of this district to a very simple and rapid method which had been devised by the eminent chemist M. Pelouze, Master of the Paris Mint, for determining the amount of sulphur existing in pyrites. He (Dr. Calvert) was induced to do so, believing that any process which would simplify the long and troublesome operations now followed to ascertain the value of this mineral would be useful to many members now present at this meeting. The process consists in mixing intimately together one part of pyrites, thoroughly pulverised in an agate mortar, with five parts of carbonate of soda, seven parts of chlorate of potass, and five parts of chloride of sodium, and placing the whole in an iron spoon, which is gradually carried to a dull red heat. The mass, when cold, is first washed with cold water and then with boiling water, until the whole of the soluble matter is removed; and this solution is tested with a standard solution of sulphuric acid. As 100 grains of carbonate of soda require 92·45 of monohydrated sulphuric acid, or SO_3HO, it

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follows that the quantity of soda in the carbonate of soda employed will decrease in proportion to the quantity of sulphur from the pyrites converted into sulphuric acid, which will have neutralised a corresponding quantity of the soda in the carbonate.

This mode of assaying is so simple that the author states that he can determine, within 1 or 1½ per cent., the value of a sample of pyrites in the space of an hour's time.

M. Pelouze also states that by employing the following proportions of the same materials, the manufacturer can determine the amount of sulphur in burnt pyrites. Five parts of the latter substance are mixed intimately with five parts of pure carbonate of soda and five parts of chloride of potash.

The Student.

VOLTAIC ELECTRICITY.

We will assume that the experimentalist is anxious at the onset to possess a voltaic battery of his own construction. The battery is an arrangement for obtaining a continuous supply of electricity in the form of a current along a wire—*dynamic* electricity; while the electrical machine furnishes a charge of electricity at rest—*static* electricity. The origin of the supply of dynamic electricity is the chemical action of a fluid upon a metal, such as zinc or iron, which forms the *positive element* of the voltaic couple. The other, or *negative* element of the couple, is a metal which is not acted upon by the fluid: charcoal or graphite also forms an excellent negative. The use of the negative element, according to a generally received theory, is merely to conduct from the fluid the electricity which is generated by chemical action upon the positive.

Let us take a strip of zinc for the positive, and one of copper for the negative element, and place them, out of contact with each other, in a wine glass containing a solution of sulphate of copper—a fluid which is without action upon copper, but which attacks and gradually dissolves the zinc. We have here a voltaic couple. To form a *circuit* for the current to pass between the metals, a thin copper wire, which has been heated red hot to render it flexible, may be attached to each element. When the free extremities of the wires are brought into contact, the circuit is completed; by removing them the circuit is broken. If these extremities, or *poles*, be placed upon the tongue, a slight pricking sensation accompanies the passage of the current. It will be observed, after a time, that the zinc positive is greatly corroded; while, on the contrary, the negative is covered with a brilliant deposit of pure copper from the solution.

To avoid a frequent source of confusion to beginners, it must be borne in mind that, although the copper forms the *negative* element, it conducts the *positive* electricity from the fluid, and the extremity of the wire connected with it is, therefore, termed the positive pole.

The sulphate of copper belongs to a large class of compounds termed salts. By the agency of electricity these may be decomposed. Without considering closely the manner in which the decomposition takes place, it may be stated that the base of a salt, viz., the metal or metallic oxide, appears at the negative pole of the battery, and the acid, or body which replaces an acid, at the positive pole. As opposite electricities attract each other, the metals are termed *electro-positives*, and correspond with the element hydrogen in water; acids are electro-negative, and correspond with the element oxygen in water.

Exp.—Into a second wine glass containing sulphate of copper in solution, lead the extremities of the wires connected with the elements of the voltaic couple. In a short time the end of the wire attached to the zinc will be coated with copper reduced from the solution; the other terminal or positive pole will be corroded by the acid of the decomposed salt.

Observations.—The quantity of copper thus reduced corresponds exactly with that which is deposited upon the copper element during the period of the experiment, and also with that which is removed by corrosion from the positive pole. With a perfect form of voltaic couple, *i.e.*, one in which there is no waste of the positive element; the quantity of copper reduced from solution in the second wine glass should be the exact chemical equivalent of the zinc consumed in the battery.

The voltaic couple we have formed in the wine glass is a tolerably powerful arrangement, and far more constant in its action than the same couple in dilute sulphuric acid. In the latter case, the copper element becomes more or less covered with minute bubbles of hydrogen gas, which impede its action as an efficient negative; and, moreover, it appears to be acted upon to a small extent by the acid*. In the copper solution, the negative must necessarily be perfectly free from any corrosive action, since its surface is constantly being renewed by the deposit of copper; and, moreover, the evolved hydrogen is instantly absorbed in the decomposition of the copper salt. On the score of economy, however, the presence of the solution in contact with the zinc is very objectionable. In addition to the consumption of zinc necessary for voltaic action, a great amount of waste is due to the chemical action of the copper salt upon the metal. The arrangement known as Daniell's couple obviates this objection. By means of a porous vessel, which allows the metals to remain in *electrolytic* contact, but prevents to a great extent the passage of the copper solution, the zinc may be immersed in pure water, while the copper is in contact with the sulphate. Thus, for every equivalent of copper reduced upon the negative an equivalent of sulphuric acid passes through the porous vessel to enter into combination with the zinc, which is effectually preserved from any further waste. In the ordinary form of Daniell's battery used in this country, a cylindrical rod of zinc is immersed in pure, or slightly acidulated water, contained in the porous jar, and a cylinder of copper surrounding the latter form the negative element. By reversing this arrangement, according to the plan adopted in the French telegraph batteries, considerable advantage is gained by the increase of surface in the zinc element.

To Construct a Cheap and Efficient form of Voltaic Couple.

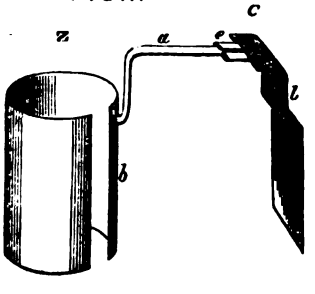
When first we had occasion to perform some experiments on our own account with voltaic electricity of high *tension*, *i. e.*, a current from a battery or several hundreds of couples united by their opposite poles, the question of expense was to us a matter of considerable moment. To avoid the expenditure of several shillings upon each couple, and at the same time to obtain a perfectly efficient arrangement, we ultimately—after several failures from defective contacts, &c.—adopted the plan embodied in the following instructions. As we believe these may be of benefit to many students possessing both the wish to construct their own apparatus, and the moderate amount of industry and mechanical skill required for the purpose, we propose to treat the subject somewhat *in extenso*.

The Battery Jar.—For the purposes of the student this may generally be as small as it can readily be obtained. The white earthen jars used for household purposes, holding about half a pint of fluid, answer very well. Brown stoneware vessels of all sizes may be obtained cheaply at the pottery. When a large number of couples are to be arranged for tension electricity, the fluid in the jars may be more perfectly insulated from the earth by attaching three small pieces of gutta percha to the bottom of the vessel as an insulating support.

The Porous Vessel.—Casting the porous jars in plaister is sometimes at first a troublesome operation, but is rendered necessary to the student by the high price at which the porous earthen vessels are generally sold. When a few of these jars only are required, the outer mould may be made of stout paper wrapped round a glass phial about four inches in diameter, and kept in shape by being tied round with thin twine. The bottom of the mould may be fastened with a wafer or a small piece of warm gutta percha. The plaister being mixed in a separate vessel, with cold water, is poured into the mould to about one-third of its capacity. A glass phial about three inches in diameter, somewhat tapering towards its lower extremity, may now be carefully inserted into the mould, and kept in position at a depth sufficient to allow for the thickness of the bottom of the jar. In a few minutes, when the plaister is sufficiently set, the bottle may be withdrawn. The outer envelope of paper, when moistened, is readily detached. When a number of jars are required, a few cylinder moulds in two halves may, without very great difficulty, be made of gutta percha.

The Zinc Element.—When it is not required to keep the battery in continuous action for a great length of time, thin sheet zinc answers very well for the positive element. This should be obtained in strips about as broad as the battery jars are high.

Fig. 1.



* Chemical action upon the negative element destroys almost completely the efficiency of the couple. This may be proved by adding a small quantity of nitric acid to the solution, this acid being a powerful solvent of copper.

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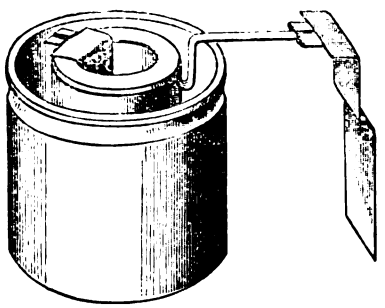
The strips are cut into lengths sufficient to form the cylinder Z, which is to surround the porous vessel. The metal is easily cut with a pair of stout scissors; and, in the absence of an anvil and hammer, the cylinders may be sufficiently well formed by hand, with the aid of a pair of pliers. A portion of metal to form the arm A is cut from the cylinder at B, and bent, as shown in the figure. As the zinc is to be immersed in pure water, the trouble of amalgamating with mercury may be dispensed with.

The Copper Element.—The thinnest sheet of copper may be used for the negative element, and should be obtained in strips of nearly the width of the inside of the porous vessel. When cut into lengths, the pieces of copper are bent with the pliers into the form shown at C. The ledge at *l* is to support the crystals of sulphate of copper necessary to maintain a saturated solution in the porous vessel. The connection at E has now to be made, in order to avoid the necessity for binding screws. This is an important part of the work of constructing the battery, as the efficiency of the latter greatly depends upon the perfection of the contacts. The upper surface of the copper at E should be brightened with a file or emery paper. A cut with the scissors is then made on either side of the strip, so as to allow a portion of the metal to be turned upwards, and over, to enclose the extremity of the arm A of the zinc element. This arm is slightly tapered, and may thus be made to fit tightly in the copper joint. This is carefully adjusted with the pliers to the size of the zinc arm, to allow this to be easily inserted or withdrawn. The couple complete, which may be constructed at the cost of a few pence, is represented below.*

FIG. 2.



PROVINCIAL AND LOCAL TELEGRAPHS.

OUR railway system has long been characterized as devoid of flexibility. It has been urged that it does not adapt itself to the wants of the country which it traverses; so it is with the electric telegraph, the telegraph follows the locomotive, and partakes of the inflexibility of the railway system. Why should not the electric telegraph be accepted as the precursor of a line of railroad? There are hundreds of opulent and flourishing towns and villages in England and Wales, upon which an expeditious means of telegraphic communication would confer incalculable advantages. Must they remain without such a boon until they are in a position to secure to themselves a line of railway? We have still our ancient high and bye-roads, why then, as in America, Switzerland, and other countries, not avail ourselves of these roads to carry on a comprehensive system of provincial and local telegraphs? From our great trunk railway lines telegraph wires might diverge right and left into the neighbouring towns and villages. Branch wires might be rented by those residing along their course—by the nobleman interested in the topics of the day, the producer anxious to know the state of the metropolitan and other markets, and the inhabitants of our rural districts. A vast amount of telegraphic intercourse would be the result, and with commensurate advantages. A comprehensive system of the kind would materially facilitate our political, commercial, and social transactions, as well as our postal and police operations.

* Arrangements will be made with an intelligent working man for the supply, when necessary, of this battery to students at the lowest possible cost, of which notice will be given in our advertising columns.

ABSTRACT OF EXPERIMENTS ON THE ELONGATION AND RETURN OF COPPER, STEEL, IRON, AND HEMP, USED IN THE MANUFACTURE OF SUBMARINE CABLES.

(*Appendix to Government Report.*)

THE data contained in the following table, constructed from experiments made under the direction of Captain Galton, R.E., are of great importance to all who are engaged in the selection or manufacture of submarine cables. This becomes evident, when it is considered that the most serious faults in several cables which have failed, have been traced to the unequal elongation and return of the metallic substances employed in their construction. The table in question appears to be the only portion of the voluminous reports relating to the outer covering of submarine cables which at all enters into the question of the *permanent* elongation and return of the wire under a strain.

Diameter of Wire, 1-32 inch. Length, 100 inches. (On Triangle.)

Weight.	Elongation.	Return.	Permanent Elongation.
lbs.	inch.	inch.	
1	·0156	·0156	·0
2	·03125	·03125	·0
3	·0625	·0625	·0
4	·0625	·0625	·0
5	·0625	·0625	·0
6	·0625	·0625	·0
7	·0625	·0625	·0
8	·0625	·0625	·0
9	·0625	·0625	·0
10	·0625	·0625	·0
11	·125	·03125	·09375
12	·156	·0625	·0935
13	·4375	·0625	·375
14	1·	·0625	·9375
15	1·75	·0625	1·6875
16	2·0625	·125	1·9375
17	4·	·0625	3·9375
18	5·	·125	4·875
19	6·5	·09375	6·406
20	8·	·09375	7·906
21	9·75	·0625	9·687
22	15·0625	·156	14·907
23	15·187	·156	15·031
24	broke down.		

EXPERIMENTS on the ELASTICITY of STEEL, IRON, and COPPER WIRES, and TARRED HEMP STRANDS.

STEEL.

Diameter of Wire, 2 25-32. Length, 100 inches.

Weight.	Elongation.	Return.	Permanent Elongation.
lbs.	inch.	inch.	
7	·0	·0	·0
14	·0	·0	·0
28	·0	·0	·0
56	·03125	·03125	·0
112	·0625	·0625	·0
168	·25	·125	·125
224	·468	·25	·218
336	·656	·25	·405
	broke down.		

IRON.

Diameter of Wire, 4-32. Length, 100 inches.

Weight.	Elongation.	Return.	Permanent Elongation.
lbs.	inch.	inch.	
14	·0	·0	·0
28	·0625	·0625	·0
56	·0625	·0625	·0
112	·125	·125	·0
168	·187	·125	·062
224	·25	·125	·125
336	·3125	·0937	·2187

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COPPER.

Diameter of Wire, 4 25-32. Length, 100 inches.

Weight.	Elongation.	Return.	Permanent Elongation.
lbs.	inch.	inch.	
7	·0	·0	·0
14	·03125	·03125	·0
28	·0625	·0625	·0
56	·09375	·09375	·0
112	·125	·125	·0
168	·187	·125	·062
224	·875	·0625	·8125
336	7·75	·0625	7·6875

HEMP.*

Diameter of Strand, 7-32. Length 100 inches. Number of Yards, 6. Diameter, 2-32.

Weight	Elongation	Return	Permanent Elongation.
lbs.	inch.	inch.	
7	·03125	·03125	·0
14	·25	·25	·0
28	·75	·625	·125
56	1·5	·563	·937
112	2·0625	·563	1·502
168	8·25	—	—
224	8·5	1·	2·5
336	4·25	1·218	3·032

* Tarred and steeped in Water before Experiment.

INDIA RUBBER.

ALTHOUGH the exportation of cocoa from Parà (Brazil) has been more considerable than that of india rubber as to quantity, india rubber may properly be termed the staple article of export, because not only is its value greater, but until recently it was the distinguishing production of this territory, in comparison both with the rest of South America and with the whole world. The discoveries of large quantities of india rubber in the East Indies, and chiefly in Malacca and the off-lying islands (from a different plant); the rapid improvement in its manipulation, and increase in its exportation to Europe; the subsequent elaboration of the same product in Central America, (where, however, it had been discovered even before this territory was explored by Europeans,) though in small quantities; the same discovery and elaboration on the western coast of South America, (as about Guayaquil;) and, lastly, the more recent discovery and elaboration of caoutchouc, of very superior quality, on the coasts of Africa; all these circumstances have stripped the india rubber trade of Para not only of its importance, but of its distinctness also. This result, which may, perhaps, change the course of commerce in this district, was due to an exuberance of prosperity. The multiplicity of inventions for the utilization of india rubber, which were practically applied since 1848, both in Europe and in the United States, has created an increased demand for the raw material. Mr. T. Hancock, of Manchester, and Mr. Goodyear, of the United States, were rivalling each other in manufacturing ingenuity, and were being multiplied by a host of imitators, all of whom became consumers of caoutchouc. Mr. Goodyear then discovered the universalising process of vulcanisation (as it is termed), whereby the uses of this product were endlessly increased. The dealers, stimulated by an unwonted and seemingly insatiable demand, entered into a wildly speculative competition in purchasing at Para, which commenced in 1853, and attained its culminating point in 1854. The same stimulus impelled others to seek for new sources of supply in other parts, where the climate and botanical characteristicts favoured the probability that such supplies would be obtained. In the meanwhile, the importations into Europe from Singapore, of a rubber of inferior quality truly, but which served many of the purposes of manufacture, and which was at first introduced at about one-fifth the price of that from Para, had considerably stanched the consumption; wherefore Para rubber, bought in this market at 2s. 8d. per lb., (the average value in England being about 1s. 8d.), resulted in such losses as reduced the value of rubber at Para, step by step, to a parity with the real value of the article in Europe and the United States.

That the consumption of india-rubber is likely to be more increased by its being used in a vulcanized state, to make the washers of machinery, to line steam boilers (as a preservative,) and even, perhaps, (as has been proposed) to the inside lining of ships, and to many other purposes requiring the employment of large quantities, is doubtless true. It is also true that the elasticity and toughness of the rubber depend greatly upon the manipulation of the milk, and, amongst other things, upon the process of smoking over a fire fed with the nuts or kernels of the Urucuri palm; but the virgin forests of Western Africa are as rich and interminable as those of this country, and all the appliances are at hand there, as here, for proper manipulation, whilst the inferior qualities of rubber, which contribute to the bulk of the consumption, are to be obtained in greater abundance in British India than here. It is the product from the *Iatropha elastica* (here called the Seringa tree, which is the best, and this tree is as much indigenous to Western Africa as to the watershed of the Amazons. A tree called here the Mangabeira, also yields a milk concreting into a rubber of inferior quality; and an attempt has been made at Ceara to establish a competing supply of rubber derived from that tree. But, as this rubber can only be available for the purposes to which the Singapore rubber (obtained from a parasitic or bind-tree), or that of the Burrampooter (obtained from the Banyan), is equally applicable—that attempt resulted in disappointment; because, owing to the listlessness and indolence of the people of this country, they can only be roused to action by the stimulus of some extraordinary advantage; wherefore, there is either little or no efficient labour, or it must needs be very costly. Already the Seringals (Seringa woods, or sites for the collection of rubber in this province) were well-nigh deserted by the settlers of the interior, during the latter part of the past dry season (1856), because rubber had fallen to 16 or 17 milreis the arroba at Para; whereas other articles (of consumption) whether native or foreign, had rather advanced than retrograded in price. And the Indian is not fond of working at any time, but he is still less so when he fancies he is working only for the advantage of the dealer who receives his produce. It is therefore not unlikely that the supply of rubber in this market will in future be scanty, unless there should be a great fall in the prices of all other articles on the one hand (which also appears improbable), or, again, a sudden immigration of energetic foreigners—which is, perhaps, the most probable contingency. If elaborated, the supply is inexhaustible, because the area over which the Seringa trees abound is immense, and because the method of collecting the milk by tapping, practised here, does not destroy the tree, like the Malay fashion of hewing down the Gutta-Percha tree.

The Seringa tree here, after being well tapped, and apparently spent for a time, revives and yields again, after a respite of two or three seasons. For the purpose of waterproofing, in which impermeability alone is essential (and not elasticity), the milk can be used, and has been used, without smoking, that is, before it is concreted; although, even when so used, it is better for being smoked, to carry off its naturally fœtid smell, (and which it loses in the artificial drying process). For this application a demand was springing up in the United States, it having been discovered that the milk could be kept liquid by being put into bottles, with a very small quantity of liquor ammoniæ, and hermetically sealed. In 1854, a sample of fifty-four arrobas of rubber milk, so preserved, was exported to New York. But hereupon the provincial government of Para took alarm lest, if this application were continued, the whole supply of the country should be exhausted, the employment afforded by the manipulation at the Seringals should be put an end to, and distress should be brought upon the working population; reasons, neither of which had the least foundation. Wherefore, a measure was immediately passed through the provincial legislature, imposing a prohibitory duty on the exportation of the liquid milk.

Formerly all, or nearly all, of the india rubber met with in this country was already fashioned, either into the form of rude bottles, or shoes, &c. The latter were freely exported (chiefly to the United States for use; but the former were mostly cut up. Now the best rubber is mostly smoked upon narrow boards, which mould it into oblong cakes, wholly free from impurities, and very convenient for packing. The exportation of rubber shoes, which formerly met the bulk of the demand, has gradually dwindled into insignificance, having been superseded by the supply of superior articles made in Europe and in the United States. There are in this country four qualities of concreted rubber, the three first of which are smoked, and the last of which is unsmoked, consisting of that which concretes, either owing to rain falling into it (whereby it is precipitated), or owing to delay in manipulating. These four varieties are known by the names of fine, medium, and coarse *Boracha*, and *Sernamby*.—(*From the Report of H.M.B. Consul, Brazil.*)

MOVEMENT OF THE ATMOSPHERE.

SOME movements of the atmosphere may be illustrated by reference to the motion of water drawn off from a reservoir by a small opening below; or by similar *upward* draught through a syphon; or by a gradual pouring in at the upper surface.

From a slight motion at the commencement, affecting only that portion of the fluid adjoining either of those places of diminution or increase, gradually all the water becomes influenced and acquires more or less rapid movement. But suppose a long reservoir or canal of fluid which has two such points of loss, or two of such filling (as imagined above), and that one of either is near each end of the vessel. If each aperture be opened at the same moment, equal effects will be caused in each half of the fluid towards either end of the vessel, but in the middle there must be a neutral point at which the water falls or rises, yet has no horizontal motion. And in the case of fluid drawn off, or diminished in weight at one end, while increased at the other, the *whole* body of water will move similarly to that in the former vessel, but unequally.

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Hence it is evident, that before horizontal motion occurs, an augmentation or a diminution of pressure must take place somewhere more or less remote:—and so it is with the lighter fluid, our atmosphere,—which has centres, lines, or areas of depression towards which currents flow (*and thence go elsewhere*).

Such considerations show, in some degree, why the barometric changes usually precede, but sometimes only accompany, changes of weather; and, though very rarely, occur without any sensible alteration in the wind current of the atmosphere. An observer may be near a central point towards which the surrounding fluid tends, or from which it diverges. He may be at the very farthest limit of the portion of fluid that is so influenced. He may be at an intermediate point, or he may be between bodies of atmosphere tending towards opposite directions.

It has been said, that "a whirlwind which sets an extended portion of the atmosphere into a state of rapid revolution ,diminishes the pressure of the atmosphere over that portion of the earth's surface, and most of all at the centre of the whirl. The depth of the compressing column of air will, at the centre, be least, and its weight will be diminished in proportion to the violence of the wind." But this has been controverted—with respect to the *general* effect of air in horizontal motion, and the depth of the column in question. Certainly there are two kinds of whirlwinds—one caused by rarefaction tending to lighten vertical pressure under the vortex, though not, perhaps, under all the current drawn towards it; and the other, a consequence of opposing winds, which occasion huge eddies or whirlwinds of compression.

Some whirlwinds are accompanied by rushes from the upper atmosphere, or from cooler spaces, which, mingling with warmer and moister air near the sea, cause dense clouds. About their centre it sometimes happens that the barometer falls as much as two or three inches, thus showing a diminution of atmospheric pressure by nearly a *tenth part*; when it must be expected, from physical considerations alone, that very dense cloud swould be formed.—*Mechanic's Magazine.*

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.—Rather more demand for fine Para, several parcels have been sold at 1s. 8½d., leaving a firm market at 1s. 9d. per pound. Other qualities remain the same.

A parcel of middling Penang found buyers at 1s. 2d.

Gutta Percha.—No sales, prices the same.

November 29th, 1861. W. Kirkman.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do. B. 7 per cent. till 1862	all	18 to 20	——
20	Do. C. " "	all	9 to 11	——
Stock	Electric Telegraph . .	100	94 to 97	——
20	Red Sea and India Telegraph	all	18 to 19	——
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	——
1	Do. registered . . .	all	3/8 to 5/8	——
10	Do. "	all	4 to 6	——
5	United Kingdom Telegraph	2	1d. par.	——
	Mediterranean Extension Tel.	all	4 to 5	——

MEETINGS FOR THE WEEK.

Monday.—*Geological School, Jermyn Street*, "On the Metallurgy of Copper and Zinc," by Dr. Percy, F.R.S., at 8 p.m.

Society of Engineers, Annual General Meeting, at 6.30 p.m.; Discussion on the Paper, "On Surface Condensers," by J. Louch, Esq., at 7.30 p.m.

Polytechnic Institution, Professor J. H. Pepper, F.C.S., "On the Iron Age, and the Science of the Armstrong, Whitworth, and other Rifled Guns."

Tuesday.—*Institution of Civil Engineers*, "On the Discharge from Under Drainage, and its Effects on the Arterial Channel and Outfalls of the Country," by Mr. J. Bailey Denton, M. Inst. C. E., at 8 p.m.

Wednesday.—*London Institution*, "On the Geographical and Geological Distribution of Organised Beings," by E. W. Brayley, Esq., at 7 p.m.

Geographical Society, "On the Bracklesham Series of Deposits," by Rev. O. Fisher, F.G.S., at 8 p.m.

Society of Arts, "On the Building for the International Exhibition, 1862," by Capt. W. C. Phillpotts, R.E., at 8 p.m.

Thursday.—*Geological School, Jermyn Street*, "On Mining," by Warrington Smith, Esq., at 3.30 p.m.

Civil and Mechanical Engineers' Society, "On Hydraulic and Steam Cranes," by Mr. Arthur Chapman, at 7.30 p.m.

Friday.—*London Institution*, "On the General Phenomena of Chymical Action, and the Laws which Govern them," by Henry Letheby, Esq., M.B., M.A., &c., at 7 p.m.

Geological School, Jermyn Street, "On Mineralogy," by W. W. Smith, Esq., at 8 p.m.

METEOROLOGICAL CHANGES.

[From the Times.]

Sir,—The following instrumental readings made at the Highfield-house Observatory will be useful, in comparison with others taken during the late gale:—

Date.	Hour.	Barometer, corrected and reduced to sea level.	Temperature in shade.	Wind.
		Inches.	Degrees.	
Nov. 24th ...	10 p.m.	30·057	28·5	W.
Nov. 25th ..	2 15 a.m.	29·981	27·5	S.
—	8 15 a.m.	29·814	42·5	S.
—	10 a.m.	29·764	44·2	S.S.W.
—	1 15 p.m.	29·672	48·0	S.S.W.
—	4 30 p.m.	29·584	48·2	S.W.
—	6 15 p.m.	29·524	49·0	S.W.
—	10 p.m.	29·443	51·0	S.W.
—	11 50 p.m.	29·412	48·5	S.W.
Nov. 26th ...	3 15 a.m.	29·348	50·5	S.W.
—	6 a.m.	29·340	52·2	S.W.
—	9 a.m.	29·342	54·0	S.W.
—	10 15 a.m.	29·335	55·0	S.W.
—	1 p.m.	29·386	52·0	W. by N.
—	2 10 p.m.	29·465	50·5	W.N.W.
—	8 p.m.	29·677	42·3	W.N.W.
—	10 p.m.	29·722	39·0	W.N.W.
Nov. 27th ...	3 30 a.m.	29·768	35·0	S.W.
—	9 a.m.	29·816	40·0	S.W.
—	1 p.m.	29·767	44·2	S.S.W.
—	2 p.m.	29·744	45·2	S.W. by W.
—	5 10 p.m.	29·761	43·0	W.S.W.

On the 24th the weather was fine, with frost all day. At 2·30 a.m. on the 25th a gale sprung up from S., with cloudy sky; from 7·30 p.m., gale more violent for three hours, changing to S.W. at 8 p.m.; at 5 a.m of the 26th rain commenced, and continued till 11 a.m.; at 12·40 p.m. the sky became very black, and the wind changed to W. by N., moving to W.N.W. at 2·10 p.m. Fine afternoon and evening. This morning, at 1 a.m., the wind became S.W., moving to S.S.W. at 1 p.m., and W.S.W. at 3 p.m. Weather fine.—I have the honour to be sir, your obedient servant, E. J. LOWE.

Observatory, Beeston, near Nottingham. Nov. 27.

Correspondence.

INSULATING MATERIALS—[*continued*].

To the Editor of The Electrician.

Sir,—Having expressed myself dissatisfied with the conclusions arrived at by the Telegraph Committee, it only remains for me now to state the reason why! I will commence at the bottom of the list as furnished in the last number, viz., Mr. Hearder's wire. This core consisted of a copper wire $\frac{1}{24}$ inch in diameter, and a coating of gutta percha of $\frac{1}{24}$ inch in thickness. Between the two coatings of gutta percha, however, a lapping of a fibrous material saturated with tar is introduced.

The report states:—"The introduction of cotton between the two layers of gutta percha is equally disadvantageous (referring to a serving of cotton next the wire) as is proved on Mr. Hearder's short line of 450 (or rather 440) yards." Professor Wheatstone in his report, page 286, states "the interposition of cotton between two layers of gutta percha is equally disadvantageous, as proved by experiments on Mr. Hearder's short line of 440 yards. Mr. Latimer Clark further describes this cable in his report, and his conclusions as to its merit. I quote his words;—

"A specimen of cable was prepared after the plan advocated by Mr. J. N. Hearder. A layer of fibrous material saturated with a tarry compound, was interposed between the layers of percha. Its electrical insulation was of course the same as that of gutta percha. Its length was one quarter of a mile, and its induction was frequently compared with a length of one

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mile of percha cable of *precisely similar dimensions*, at a temperature of 33° with 128 cells. The following is a specimen of the result :—

Hearder's Cable.	Gutta Percha Cable.
°	°
8·8	33·2
9·0	33·1
9·0	33·2
9·0	33·1
9·0	33·4
9·0	33·4
9 0	33·2
8·9	33·2
8·9	33·0
8·9	33·2
Average 8·95.	Average 33·20.

"By multiplying the average by four, it will be seen that no advantage is obtained by the use of this form of cable, but rather the reverse."

The diameter of copper on Mr. Hearder's cable, as I have already observed, was $\frac{1}{32}$ of an inch, the thickness of coating including the tarred fibrous lap, was $\frac{1}{32}$ of an inch. I have looked in vain in the appendix for a core of similar dimensions subjected to experiment. The nearest approach to it is that of a gutta-percha core with a wire $\frac{1}{8}$ of an inch in diameter, and a thickness of coating of $\frac{5}{32}$ of an inch. Compared with such a core, Mr. Hearder's plan seems to stand well.

Taking the discharge upon this latter core as 33° 2 per mile, as given in Mr. Clark's table above, the discharge upon Mr. Hearder's, with a considerable less thickness of coating, should have been, according to the law of induction, about 44°.

The following table compiled from the experiments in Appendix No. 6 will show how far Mr. Hearder's principle has failed in insulation for static electricity in comparison with another wire having a thicker coating.

TEMPERATURE 32° F.

Tension of Battery 65°·75 ; 66°·5.—March 12–19.

Description of Wire.	Induction. Charge.	Induction. Discharge.	Earth.	Insulation. The index fell from full to 60° or ½ tension in	Insulation. The index fell from full to 49·5 or ½ tension in	Insulation. The index fell from full to 32°·25 or ¼ tension in	Insulation. The index fell to zero (½ tension) in	Insulation. The index fell in 1 minute to
			°	′ ″	′ ″		′ ″	
Gutta Percha $\frac{6}{32}$ $\frac{7}{32}$	22·4	22·0	—	0 55	2 7		3 16	59½
				1 0	2 44		3 5	60
Hearder's Wire (440 yards.)	6·0	6·0	0·1	1 20	3 55		- -	48½ in 5
				1 55	4 45			5′
TEMPERATURE 42° F.								
Gutta Percha $\frac{6}{32}$ $\frac{7}{32}$	21·0	21·0	0·0	0 33	1 20		1 30	54·
				0 32	1 31		1 40	55·5
Hearder's Wire (440 yards.)	6·6	6·3	0·0	0 32	2 35		2 40	58·
				0 35	2 45			58·5
TEMPERATURE 52° F.								
Gutta Percha $\frac{6}{32}$ $\frac{7}{32}$	22·4	21·9	0·4	0 8	0 24		0 32	32·5
				0 10	0 30		0 34	33·
Hearder's Wire 440 yards (do.)	24·9	24·7	0·3	0 12	0 40		0 55	43·
				0 15	0 40		1 0	43·
TEMPERATURE 62° F.								
Gutta Percha $\frac{6}{32}$ $\frac{7}{32}$	22·3	21·4	0·9	0 6	0 18	35″	0 16	13·5
				0 7	0 18	33″	0 18	13·5
Hearder's Wire 440 yards (do.)	23·9	23·0	0·1	0 14	0 40	1′ 20″	0 38	38
				0 15	0 44	1′ 40″	0 44	41
TEMPERATURE 72° F.								
Gutta Percha $\frac{6}{32}$ $\frac{7}{32}$	24·0	22·2	2·1	0 5	0 10	0′ 21″	0 11	5·
				0 5	0 10	0′ 20″	0 12	5·
Hearder's Wire 440 yards (do.)	24·9	24·1	1·2	0 6	0 16	0′ 37″	0 18	19·
				0 7	0 17	0′ 40″	0 19	21·
TEMPERATURE 82° F.								
Gutta Percha $\frac{6}{32}$ $\frac{7}{32}$	27·3	24.4	4·8	0 3	0 5	0′ 10″	0 8	zero.
				0 3	0 5	0′ 10″	0 8	
Hearder's Wire 440 yards (do.)	27·0	25·4	2·3	0 5	0 9	0′ 25″	0 11	12·5
				0 5	0 10	0′ 22″	0 11	11·5
TEMPERATURE 92° F.								
Gutta Percha $\frac{6}{32}$ $\frac{7}{32}$	34·3	28·1	9·5	0 3	0 5	0′ 8″	0 8	zero.
				0 3	0 5	0′ 8″	0 8	
Hearder'r Wire 440 yards (do.)	29·6	26·4	4·5	0 4	0 7	0′ 15″	0 9	zero.
				0 4	0 8	0′ 16″	0 10	

Yours, A.

To the Editor of THE ELECTRICIAN.

SIR,—In your last number you observe that the expression "*intensité*" as applied by foreign electricians, is of somewhat indefinite meaning ; this I consider is not the case—the expression, as used by continental writers, has, unfortunately, the same signification as the word "quantity" in this country. If we assume, for instance, that a perfectly insulated wire exists between London and Edinburgh, and that a given electromotive force be applied at one end : we know that a certain quantity of electricity would flow through the wire, and if the electromotive force were doubled, the quantity of electricity flowing through the wire would also be doubled; and we know that whatever quantity entered at one end of the wire, the same quantity would flow out at the other. French writers would express this by saying that the "*intensité*" of the current was twice as great in the one case as the other, and that the "*intensité*" was equal at both ends of the wire, using the word to express the same idea as we attach to quantity. The young telegraphist should here be reminded that the force with which an electric current affects a galvanometer, or an electro-magnet is directly proportional to the quantity of the current passing through the coil, without any reference to its tension ; thus in the case above cited, the tension of the current might be very great at London, and almost inappreciable at Edinburgh, and yet a galvanometer inserted at each place would experience precisely the same deflection, because the quantity would be the same. It is difficult at first to believe that the tension, or the number of cells has nothing to do with the deflection of a needle, because it appears so contrary to daily experience, but a very simple experiment will readily demonstrate it ; if he wind his galvanometer with very thick wire he will find that a series of 100, or even 1000 cells will not deflect his needle any more or less than one cell, because although the tension is immensely greater, the quantity is the same in each case, the increased deflection obtained with fine wire galvanometers is simply owing to the increased quantity which the extra tension of the battery forces through the wire.

When we speak of the intensity of heat or pressure, we refer to its degree without reference to its quantity ; thus an oxyhydrogen light has a much more *intense* heat than a house on fire, although its quantity, or volume, is immeasurably less. The idea of intensity, as originally applied to electricity, was doubtless intended to convey a similar meaning, the increased energy of the current produced by high battery power, being wrongly attributed to the direct influence of tension, instead of its indirect effect in increasing quantity. As juster views now prevail, it is better to abandon the use of so ambiguous a word as intensity, and confine our ideas only to quantity and tension. The word *intensité* may always be translated into English as strength, or quantity.

Electromotive force, potential, and tension, have all the same meaning, and when used by French writers have the same signification as we attach to them. They are already beginning to use the word *quantité* to supplant that of *intensité*, and when they do so we shall all be using a common language.

LATIMER CLARK.

London, November 28th.

PURIFICATION OF WATER.

To the Editor of THE ELECTRICIAN.

SIR,—I have read with much interest the article on the purification of water, which appeared in your paper of the 16th inst. What you assert of the remarkable purifying properties of the per-manganates, if correct, would seem to me to be of the utmost importance to the public, and to constitute one of the greatest discoveries of the age. I had looked into several of the standard works on chemistry and *Materia Medica* without succeeding in meeting with any mention of these properties of the per-manganates. I therefore imagine they must be a recent discovery. Is it known to whom this discovery is due? Writing as one familiar with the subject, you can doubtless enlighten me and others less well informed than yourself on these matters, as to the history of these remarkable substances.—I am, sir, your obedient servant, F. N.

[The powerful oxidising properties to which the disinfecting action of the manganates and permanganates is due, have long been known to chemists, and are mentioned in most modern works. *Vide* "Abel and Bloxham's Chemistry," in which a full description of the preparation of the salts is given. Some interesting articles on the subject have occasionally appeared in the *Pharmaceutical Journal*. *Condy's Disinfecting Fluid* is an alkaline permanganate ; and we believe that the practical introduction of this agent is due to Mr. Condy. It has recently been proposed to disinfect sewage by means of a cheap compound, containing permanganic acid.—E. E.]

To the Editor of THE ELECTRICIAN.

SIR,—Will you allow me to say that I think your periodical would be more widely circulated if there were introduced into its columns some simple experiments and elementary information and manipulation, such as amateurs might freely indulge in. The articles are a little too scientific for the million. May I, in the next place, ask a few questions :—

1. If a Horse-shoe permanent magnet gets rusty, what is to be done to clean it without destroying any of the magnetism ?

2. How to join two of the above of unequal power, so as to form a compound magnet ? Should the dissimilar poles be placed above each other with a piece of card between to prevent contact ?

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3. Does solder in the case of a join present as good a conducting medium as copper wire, which is unbroken; and if not, is it advisable to twist the ends of the wires spirally round each other, for about an inch before soldering them?

4. It might prove a very interesting article to some of your readers to describe the necessary conditions of battery, wire, length of helix, &c. &c., for magnetising needles and small bars, &c., by a galvanic current.

5. A safe method of using lightning conductors which are inside a house as mine is, so as to ring the "Electrical Bells," by atmospheric electricity in its passage to the earth?—Yours very truly,

Lindfield, Cuckfield, Nov. 22, 1861. J. H. SEWELL.

[1. We have removed rust from our steel magnets by softening with oil and rubbing with chalk or tripoli. The magnetism is not easily destroyed except by violent concussion or vibration, such as would be caused by a file. 2. The opposite poles should be brought together if one of the magnets is to act as the armature of the other, otherwise the power of both magnets might be weakened, and that of the smaller one destroyed. The interposition of card-board is not necessary. 3. The metal of which the solder is composed is not so good a conductor as copper; but the joint, if properly made, will offer less resistance than an equal length of the single wire. The wires are brightened, twisted together, and the twisted portion covered with solder. A neater method, and one which saves trouble, is to electrotype the joint. We have contrived a small apparatus for this purpose, which may be attached to the wire when the latter is suspended; this we shall shortly describe. 4. *Vide* a paragraph in the present number. 5. Suspend one or more metallic balls to the lightning conductor, and at a short distance place the same number of bells connected with the water or gas piping.—E. E.]

To the Editor of THE ELECTRICIAN.

SIR,—Reading your paper, THE ELECTRICIAN of last Saturday, upon the different external coverings applied to the insulator, and how all have failed, has proved me that I was right in the views I hold as to the use of the reboiled gutta for such covering. It was always, to my mind, a perfect failure to make a tarred rope a protector; the reason is, that it is much liked by certain animal creations in the sea, being burrowed by shell-fish and worms *which adhere to the cable, and which leave a fatty and oily matter continually at work* soaking through theinsulator, and, if of rubber, resulting in its perfect destruction in a few hours, the rubber becoming sticky, and causing decomposition to take place, as I have always said would have been the case.

Saturate well the protecting sheathing with the reboiled gutta before twisting it into a rope, and when wound round the insulating core it will make an excellent jacket either to an india-rubber or gutta-percha insulator.

NOTE. (Report, page 9.)—"That the teredo had eaten through the tarred hemp, which he enjoyed much, no doubt, but when he came to the gutta it was not so easy a matter to masticate or to swallow." W.

[We are sorry to be compelled to differ from our correspondent with regard to the action of the teredo upon caoutchouc. We have ourselves examined india-rubber which had for several years been employed for marine purposes, and no trace could be found of its ever having suffered from the attacks of the toredo or other submarine glutton. The suggestion of our correspondent with respect to the employing of the reboiled gutta percha as an outward jacket is worthy of consideration.—E. E.]

Miscellanea.

ECLIPSE OF THE SUN.—Photographers and astronomers are on the *qui vive*, making their preparations to observe the eclipse of the sun of the 31st of December next, to which the recent discoveries of MM. Bunsen and Kirchoff in celestial chemistry impart a new and additional interest. One point to which observation will be specially directed is the examination of the spectrum of the corona with which the moon will be surrounded for a moment, in that portion nearest the sun, to see if this aureola exhibits an inversion of the ordinary solar spectrum or not—that is to say, whether Frauenhofer's rays will be replaced by brilliant lines. Since the publication of the labours of MM. Bunsen and Kirchoff, the question of a solar atmosphere has acquired a basis, and is susceptible of proof by direct experiment. If, for example, the spectrum of the aureola which will be produced on the 31st of December next, exhibits to us an inversion of the solar spectrum, the much-vexed question will be solved, and the existence of a solar atmosphere will become a definite scientific fact. If the contrary should be the case, we may be compelled to admit that absorption takes place in the substance of the photosphere, the surface of which emits not only all the rays, but which doubtless contributes to the light of the sun by a part of its thickness; whichever it may be, the experiment is not impracticable, as it has already been performed. Sig. Fusinieri, of Vicenza, on the occasion of the magnificent solar eclipse of 1842, analysed the spectrum of the aureola. It appears, however, that he did not attach that importance to it that recent discoveries have now rendered evident. He contented himself with remarking that *green* was entirely absent from the spectrum of the aureola.—*Photographic News.*

TELEGRAPH EXTENSION.—The *Sydney Morning Herald* makes the following statements in reference to intercolonial telegraph extension:—"The Superintendent of Telegraphs has just returned from the southern districts of the colony, which he visited for the purpose of opening the extension from Gundagai to Deniliquin. This line, which passes through Wagga Wagga, is connected with a private line from Deniliquin to Echuca, where there is a junction of the Victorian and South Australian wires, by way of Castlemaine and Ballarat. There is, consequently, now a separate line of communication with Melbourne and Adelaide, which may be made available for messages in the event of an interruption upon the other lines southward of Gundagai. The line between Deniliquin and Echuca was constructed by a private company, from whom it has been purchased by the Government at its original cost, which, with the office-furniture and instruments, will amount to £2,820. Upon the opening of the new line, which took place the first week in this month, a message was transmitted from the Minister for Public Works, congratulating the inhabitants of Deniliquin on the opening of a telegraph line which would place them in immediate communication with the most important points of the colony, as well as with the neighbouring colony of South Australia, and shortly with Queensland. The other extension, that from Deniliquin to the frontier of South Australia, has not yet been put in hand, and there seems a doubt whether it will be proceeded with. As it was only intended as an auxiliary line, so as to be available for communicating with Adelaide during a stoppage upon the existing line, its construction is not regarded as a matter of much urgency."

ELECTRO-MAGNETIZATION OF STEEL BARS.—Eight or ten yards of very stout insulated copper wire may be wound round a cylindrical piece of wood of somewhat larger diameter than the bars to be magnetized, so as to form a short and thick coil of four or five layers. The spirals may be kept in position by tying with twine or thread. The steel bar to be magnetized is placed within the cylinder, and a small piece of soft iron held to each of its extremities. A current from three or four Daniell's couples united together by their similar poles is then passed through the helix, which is three or four times moved up and down to the ends of the bar, and then brought to rest in its centre. Upon breaking the battery circuit the bar will be found to be powerfully magnetized. The steel should previously be tempered by plunging it, at a cherry-red heat, into cold water.

THE DIVINING CIRCLE.—The following early application of the magnet for indicating letters and sentences is interesting. It is an extract from the "Enfield Encyclopœdia," published in 1809:—"But there are not many of the magnetic experiments more interesting or entertaining than that of the divining circles. They are drawn on paper pasted on the top of a thin box. The index is fixed on the axle of a toothed wheel, which works into a pinion. On the axle is another pinion of the same number of teeth, that puts in motion a second wheel of the same size and number of teeth as the first wheel. On the axle of the second is fixed the bar magnet, and they turn together. Over this axle (but independent of it) is fixed a point for the loose needle to turn upon, and which is the centre of the pasted circle. In the compartments of this circle are written answers to the questions asked in the compartment of the first circle. A carton of strong paper should cover the pasted circle, and turn exactly on the centre. It should have one of the triangular pieces cut out, in order to see the answers. If then the needle is taken off its point, and a person wishes to ask some of the questions on the carton, the person must turn the index to the question, and then place the needle on its point, giving it a whirl round, when it will stop over the answer. The open part of the loose carton being turned to that place will exhibit the answer."

THE MERCURIAL MINIMUM THERMOMETER.—(To the Editor of the "*Illustrated London News.*")—Your Number of the 16th inst. contains a description of a mercurial minimum thermometer, which is, in fact an attempt to utilise a fact first brought forward by Mr. B. Stewart, of the Kew Observatory—viz., that a mercurial bulb, connected with two capillary tubes of different sizes, will always expand into the larger, while contraction will only take place in the smaller tube. Giving full credit to the inventor for the neat, ingenious instrument suggested, there is a weak point in it which must detract much from its usefulness, and has stood in the way of any earlier attempt to give a practical value to Mr. Stewart's experiment, for no doubt the thought has occurred to others, as it did to the writer long since, whether the principle announced by Mr. Stewart could not thus be rendered useful. There is little doubt but that the instrument described will register the minimum temperature, provided there has been a constant fall of the temperature from the time the instrument is set to the time of the greatest cold: it does not matter what increase of temperature there may be after that point has been attained: but any rise of temperature before the minimum is reached causes a virtual abstraction of mercury from the instrument into the small bulb at the top, and the thermometer will consequently register lower than the actual temperature, to a greater or less extent, in proportion to the quantity of mercury passed into the small bulb, and therefore, under these circumstances, which are as likely as not to occur any day, this instrument cannot be relied on.—W. SYMONS, 17, St. Mark's-crescent, Regent's Park.

THE capital for the New Telegraph to India Company has been fully subscribed, and the shares have been allotted. The vessel with the cable on board is expected to leave England within a month.

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ATMOSPHERIC ELECTRICITY.—The violent storm and consequent destruction of buildings in Belgium, on February 19, 1860, gave rise to much discussion amongst the scientific men of that country, with regard to the origin of atmospheric electricity and storms in general, and the cause of the frequency of lightning and thunder in winter. Among the most recent theories, that which ascribes storms to the disengagement of electricity by the evaporation of the waters of the sea and land seems to be the best established, since it rests on electro-chemical phenomena, which in nature fully account for the production of large quantities of electricity. "If," says M. Montigny, one of the investigators, "the results obtained by recent inquirers compel us to entertain serious doubts regarding this theory, there then remains to us no explanation of the origin of atmospheric electricity, which we can reconcile with our experience, and with the exigencies of natural phenomena." M. Florimond, who has written a paper on the subject, endeavours to revive the theory according to which the electricity of storms is ascribed to the friction of liquid and solid masses driven by violent winds, particularly in winter. With regard to the storm of February 19, 1860, he bases his calculations on the distances of the places struck, with the intervals of time between the electric strokes. It seems to him very credible that the mass of hail and snow, moving with a velocity of from twenty to fifty leagues an hour, should have occasioned a friction, which gave rise to floods of electricity. This electricity, he believes, acquires a high tension by the rolling of the cloud itself, and thus becomes capable of producing the well-known effects. He invokes in favour of his theory the electricity disengaged by friction of steam and water in Armstrong's hydro-electric machine. M. Florimond's theory is objected to by Montigny and Gloesener, in a report to the Academy of Sciences of Belgium, an analysis of which is given in *l'Institut*. According to the opinion of M. Florimond, the storms near the sea-shore where there are no trees ought not to be more terrible than those in summer; yet they are so. Contrary, also, to the opinion of M. Florimond, the number of electric discharges is not greater in places where trees have been cut down, than formerly, as shown by the observations collected by M. Quetelet.

THE Meteor of November 19, judging from the various accounts of it which have appeared, must have been a most magnificent one. The following account is given by Mr. James Chapman, light-keeper of the North Foreland Lighthouse, Thanet, in which he graphically describes the incidents attending the phenomenon. He states that at 9.45 P.M. the meteor passed from south to north, about 10 degrees east of our zenith. Its visible length occupied at least 70 degrees, and its diameter was not much less than that of the moon, which shone brightly at the time in a nearly cloudless sky. The meteor exceeded the moon in brightness, and its tail tapered to a flickering point. Its line of direction seemed to incline towards the earth, and, when bearing about north by west, at about 5 degrees of altitude it separated into two parts, and in about half a second broke into many luminous fragments. About two minutes after its disappearance Mr. Chapman heard two distinct reports, resembling those of musket-shots, which, perhaps, they were, but which he thinks may have been produced by the sudden immersion into the water of two or more highly heated bodies. Mr. W. Lynn, of the Greenwich Observatory, states that, while looking at the moon at about 9.38 on the same night, his attention was arrested by a most magnificent meteor, apparently a quarter of the size of the moon, carrying behind it a splendid coloured train emitting sparks. It appeared to pass from a point between Orion and Aldebaran, pursued its course slowly southward, below Castor and Pollux, and finally, at about 10 or 15 degrees north of those stars, broke into three or four fragments and vanished. The duration of visibility was nearly ten seconds. A writer in the *Morning Star* says that while walking between Lee and Eltham at about 9.50 on the same night "a ball of fire presented itself to his right (the south) and slowly floated across his path, at an apparent elevation of 100 yard, and burst into fragments, seemingly as of many stars." A writer from Bognor, referring doubtless to the same meteor, says also that "its tail had the colours of the rainbow, that it exploded, like a rocket, into several balls of fire, and disappeared."

TELEGRAPHING BY OCCULTATIONS.—Mr. H. J. Rogers, of New York City, claims to have invented this system in 1844, seven years before the paper of Professor Babbage was printed by the Lighthouse Board of the United States.

ARTIFICIAL MAGNETS.—The following is a simple and efficacious method of making artificial magnets, which has been successfully practised by Mr. Barlow. Having occasion for thirty-six magnets, 12 inches long, $1\frac{1}{4}$ inch broad, and $\frac{7}{8}$ths of an inch thick, he placed thirty-six bars of steel of these dimensions on a table, so as to form a square, having *nine* bars on each side, the marked or north pole of each bar being in contact with the unmarked or south pole. At the angular points of the square, the under edges of the bars were brought into contact, and the external opening thus left was filled up by a piece of iron $1\frac{1}{4}$ inch square, and $\frac{7}{8}$ths of an inch thick. The horse-shoe magnet was set upon one of the bars, so that its *north* pole was towards the unmarked end of the bar, and was then carried or rubbed along the four sides of the bars, and the operation was continued till the compound magnet had gone twelve times round the square. Without removing the magnet, each bar was turned one by one, so as to bring their lower sides uppermost, and the horse-shoe magnet was made to rub along the four sides of the square other twelve times. The bars were then highly magnetized, and the whole process did not occupy more than half an hour. This process is the simplest, quickest, and most efficacious; when a person is in possession of one good horse-shoe magnet, consisting of three or four bars joined together, he may afterwards make any number at the same time: indeed, the more the better. In removing the bars from each other after they have undergone the operation, it is advisable to place small pieces of soft iron on the poles of each before they are separated; for it is a fact well known to experimentalists, that a very considerable portion of the power of a bar is lost at the moment of its separation from others that have been impregnated with it; nor is it possible by any means to secure the whole of the magnetism that has been given to it. By following the plan recommended above, however, it will be found that a much larger portion is retained. The whole of the bars become in fact, as one single magnet; and the act of separation, is of course, analogous to that of fracture. Magnets should, when laid aside, be placed as nearly as possible in the position which they would assume in consequence of the action of terrestrial magnetism. If this be neglected, in process of time they will become gradually weaker; and this deterioration is most accelerated when its poles have a position the *reverse* of the natural one. Under these circumstances indeed, unless the magnet be made of the hardest steel, it will eventually lose the whole of its magnetic power. Two magnets may also very much weaken each other, if they be kept, even for a short time, with their *similar* poles fronting each other. This will readily be understood from what has been said with regard to magnetic induction. The polarity of the weaker magnet is rapidly impaired, and sometimes actually reversed. All rough and violent treatment of a magnet should also be carefully avoided: every concussion or vibration amongst its particles tends to weaken its power. Horse-shoe magnets should have a short bar of sort iron, adapted to connect the two poles; and should never be laid by without such a piece of iron adhering to them. Bar magnets should be kept in pairs, with their poles turned in contrary directions, and the dissimilar poles on each side connected by a bar of soft iron, so that the whole may form a parallelogram. They should fit into a box when thus arranged, so as to guard against accidental concussion, and to preserve them from the dampness of the atmosphere. They should be polished, not with a view of increasing their magnetism, but because they are then less liable to contract rust. Both single magnets and needles have their powers not only preserved but increased, by keeping them surrounded with a mass of dry filings of soft iron, each particle of which will react, by its induced magnetism, upon the point of the magnet to which it adheres, and maintain in that point its primitive magnetic state. The following simple method of magnetizing steel bars was published by M. P. Elias, of Haarlem (*Phil. Mag.*, vol. 25, p. 348). From 23 to 25 feet of well insulated copper wire are wound so as to form a hollow, very short, but very thick, cylinder. A current from a strong voltaic pair is passed through the wire, and the steel bar to be magnetized is placed in the cylinder in which it is moved up and down to the very ends. When the central portion of the steel bar again occupies the cylinder, the circuit is opened, and the bar, which is now perfectly magnetized, is withdrawn. When the bar is curved in the form of a horse-shoe, it is well to close it with its keeper during magnetizing; and when a straight one, to provide it at top and bottom with a piece of soft iron. The wire employed is $\frac{1}{8}$th of an inch in thickness. The voltaic apparatus is a single pair of Grove's (368), which has $\frac{1}{3}$rd of a square foot of active platinum. The resistance which the current meets with in this battery, is equal to that of a clean copper wire of $\frac{1}{43}$th of an inch in diameter, and 13 inches long. The hollow cylinder is 1 inch high; the bore nearly $1\frac{1}{2}$ inch in diameter, and the sides $1\frac{1}{2}$ inch thick. By means of this process, a steel horse-shoe bar, weighing 34 pounds, was magnetized to saturation by one single passage through a cylinder, constructed purposely for the experiment.

MESSRS. GLASS, ELLIOT, AND CO. have made a contract with the new Telegraph to India Company for the supply of 200 miles of cable, which will be sent out to the Red Sea within a month.

NEW SCIENTIFIC SOCIETY.—A Society has recently been formed in Manchester, under the title of the "Scientific Students' Association." This Society owes its origin to a few scientific tyros, who, having experienced great pleasure and profit from attending the sectional and other meetings of the British Association, during the late visit to Manchester, determined to form a little Association for the benefit of the Manchester lovers of science. Mr. L. H. Grindon consented to act as Chairman, and a Committee and other officers were at once appointed, consisting mainly of the originators of the scheme. The members meet, for the present, once a fortnight, for the purpose of hearing and discussing papers on subjects connected with physical and natural science, which are illustrated, as far as possible, by specimens, experiments, diagrams, the microscope, &c. Excursions will also be occasionally arranged.—*Engineer.*

To Correspondents.

FAIR PLAY.—We believe that the first telegraph instrument manufactured in England was for Mr. Fothergill Cooke, in 1836, by the veteran telegraphist, Mr. Brittain, the chief of the instrument factory of the International and Electric Telegraph Company.

T. F. R.—*Cable sheathing of light specific gravity.* See Messrs. Hall and Wells' advertisement in present number.

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The Electrician.

Vol. I. No. 5.—December 6, 1861.

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THE ELECTRICAL ACARUS.

Has anyone lately seen a living specimen of the interesting multiped whose first recorded appearance produced such a sensation, and occasioned such a chorus of vituperative sarcasm against its intelligent and simgle-minded discoverer? Or did the insect, like a comet, make its appearance for a brief space, and then sink into void and oblivion? Whatever hypothesis we may adopt to explain the extraordinary phenomenon of the appearance of animal life under such apparently disadvantageous circumstances as those set forth in a subsequent column of our present number, the fact must remain as one of the most curious and instructive in connection with physical science. It is one of those facts, on the confines of two sciences, which often give rise to a new science. Of course the easiest explanation of the phenomenon is to deny that it ever occurred; but this mode of settling the question is less respectable even than the negative evidence which has been brought forward for the same purpose. The fact has been asserted on undoubted testimony, and has been confirmed by the same. It may now be, not only verified, but also perhaps amplified, by the student who has already obtained some insight into the nature of electrical action. Indeed, for ought we know, many in this country or abroad, may, at the present moment, be following out the researches initiated by Mr. Crosse.

The arrangement of the molecules of matter in crystallization, their symmetrical disposition as shewn in isomorphous bodies, and the changes in their construction as evidenced by isomeric compounds, are sufficiently wonderful; but are surpassed in interest by the changes which take place in the spontaneous decomposition of organic compounds; and, as it would appear, in inorganic matter under somewhat similar conditions produced by electrical influences. Whether the effect of these changes, when they result in the formation of an organism, either vegetable or animal, is to be traced to the assimilative action of a germ of organic life, occasionally so minute as to defy the most careful microscopic examination, and everywhere present in the atmosphere; is, with many similar questions, still a disputed point. We know, however, that it is scarcely possible to allow the decomposition of compounds containing the elements of organic structures to take place without the appearance of various forms of life. In electricity we have a special agency of decomposition, as of reconstruction; which in nature probably plays an important part in influencing vegetation; as well as in the formation of mineral compounds. This influence of currents of electricity upon vegetation has occasionally been made a subject of inquiry; though, owing perhaps to the disinclination which commonly prevails to blend together *two* sciences in an object of research, the subject has not received all the attention it deserves.

The question suggested by the discovery of the electrical *Acarus* is not necessarily whether the *creation* of an organism can be an effect of electrical influence upon organic matter, but whether the latter can be brought, by means of a current of electricity, under the conditions which prevail in decomposing organic matter. Assuming that a medium compounded of air and water, in contact with various earthy bodies and salts, may have the affinities of its elements so modified by electrical action as to cause it to yield readily the constituents required for the growth of organic germs, we establish an analogy between some of the experiments of Crosse and the action which takes place during the decomposition of organic substances. In both cases, the changes which occur are probably due to electrical causes; but, in the case of the inorganic compound, the electrical agency is artificially applied.

The appearance of the animalcule at the positive pole of the galvanic arrangement, might be susceptible of some explanation, as the polarised surface in this case would necessarily be in contact with the supporter of animal life—oxygen gas. Somewhat unaccountably, the inspect appears to prefer the negative electrode. The supply of the organic element *carbon*, necessary for the development of the *Acarus*, appears also in some instances difficult to account for, unless it may be traced to impurities existing in the water. The whole subject is one which demands an adequate investigation by the chemist and the electrician; which perhaps might afford a solution of one of the most extraordinary problems of modern science.

NON-INFLAMMABLE FABRICS.

In the *Mechanics' Magazine* of November 11, 1859, attention was drawn to the then recent discovery of Messrs. Versmann and Oppenheim, analytical chemists, of Bury Court, St. Mary Axe; through which, at a very small sacrifice of time, trouble, or money, any fabric liable to accidental ignition may be protected against such danger, and rendered perfectly non-inflammable. The notice in question was at the time quoted by all the leading daily papers, whose anxiety to disseminate the knowledge of this important discovery was no less than that of our contemporary. The process recommended by Messrs. Versmann and Oppenheim, was the result of a long and careful inquiry, made by desire of Her Majesty, and entrusted by the Master of the Mint to these chemists. The object in view was the attainment of an easy and efficient means of guarding against the frequent and terrible accidents resulting from the ignition of female attire, curtains, bed-hangings, &c.; and, most happily, this object was completely secured. Out of a large number of compounds examined, two salts only were found to be perfectly efficacious for the required purpose, and at the same time not to injure the materials subjected to the protective process. These are, firstly, the *sulphate of ammonia*, which is adapted for the use of manufacturers, and secondly, the *tungstate of soda*, which is the only salt that allows the iron to pass freely over the fabric, and which therefore is adapted for laundry purposes.

Nevertheless we are too often reminded by the recurrence of frightful casualties involving the agonizing death of one or more human beings, mostly of the gentler sex, of the neglect with which this valuable invention has been received. Such casualties may be occasioned by the most trivial accidents. A lady is fumigating her apartment with toilet vinegar, a few drops of which become ignited and overflow upon the poor creature's dress, which, being of cotton or muslin, envelopes her in one moment in a blaze. Or, more simply still, a corner of her dress is wafted to the fire or candle, with the same result. From any such incident follows one of those fearful and sickening scenes, which, according to the Registrar-General, have occurred *two thousand one hundred and eighty-one times* in five years, viz.: the burning to death of a human creature by flames, from which there can be no escape by flight. Well may the Registrar-General exclaim:—"Why are combustible dresses carelessly worn. Eight persons should not be burnt to death in seven days. Such deaths can scarcely be considered inevitable accidents!"

It is not alone the dresses worn by ladies which require to be

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protected from the effects of flame; bed hangings and window curtains, when not of woollen fabric, should be subjected to the preservative process. Were this even difficult or expensive, the expediency of adopting it where flame and fuel may so readily be brought into contact might well be urged.

While the means placed at our disposal by science for the protection of life are thus ignored; various substances which have been found by scientific investigation to be inefficient for the purpose in view, are extensively advertised, and are to some extent, palmed upon the public. Among these substances are the *borate* and *silicate of soda;* the former of which causes the fabric to become rotten; while the latter, being decomposed by the carbonic acid of the air, encloses the fair wearer in a constant cloud of powdered flint and carbonate of soda.

We sincerely hope that the publicity we have given to this matter may have some effect in the prevention of accidents from fire. Fire, man's most useful servant and most terrible enemy, is ever present where mankind abides; and, this being the case, the danger of being arrayed in, or surrounded by, highly combustible material is sufficiently obvious to render the adoption of any safeguard a matter of common prudence.

Review.

TELEGRAPHIE ELECTRIQUE. By J. Gavarret.

[Continued from page 38.]

The third and last chapter of the work is devoted to the three following questions:—First, the various modes of establishing the communication with the stations of the line; second, the nature and origin of the disturbances which affect the transmission of the current on long lines; and third, the conditions imposed upon telegraphic correspondence by the laws which determine the propagation of electricity in linear conductors.

The method proposed by M. Gaillard to establish the communication of a central station simultaneously with a number of branch stations, is as follows:—the wire, in the first instance, unites the two most distant stations; and branch wires are led from this main wire to the different stations, passing through the necessary instruments and to earth. Thus, each branch station is worked by a *circuit of derivation;* the resistance of more than one instrument on circuit being avoided.

It is shown by M. Gavarret that considerable advantage in point of economy is gained when two wires of considerable length and of nearly equal resistance are worked by the same battery.

In the researches of M. Bréguet upon the loss of electricity in land wires, due to defective insulation and atmospheric conduction; it is stated that the means of the *intensités* (quantities) of the currents at the point of departure and the point of arrival are as follows, the difference being due to the escape of electricity by defective insulation:—

Current from Paris to Rouen	
1° On fine days	3,487
2° On rainy days	4,112
Current from Rouen to Paris	
1° On fine days	4,848
2° On rainy days	5,098

The cause of the difference in the results obtained in reversing the direction of the current is not explained; nor is it stated in what degree the loss was supposed to be attributable to atmospheric conduction. In another paragraph M. Gavarret states that, for several years after the establishment of the first telegraph lines in France, the transmission could not be effected beyond 100 or 150 *kilometres*, by reason of the defective methods of suspending the wires. To this cause we should be disposed to attribute almost the whole of the loss observed by Bréguet, and, in another course of experiments, by Matteucci. In this section, the effects of an accidental earth contact, according to its position upon the line, are carefully studied. The methods of determining the point of rupture or earth contact in a faulty wire are not described, though their importance is referred to as follows:—

"In electro-telegraphy it is of extreme importance to ascertain methodically the exact point of the line where a *derivation* (contact), or any other disturbance, has occurred; an operation which should be conducted with the greatest care. It is not our present intention to enter upon this subject, which, properly treated, would necessitate very ample details. We will content ourselves by stating, that the judicious application of the laws of electric currents is extremely useful in such inquiries. The resistance of the line in its normal condition, and the amount of battery power, being ascertained beforehand; a series of observations upon the quantity of the current sent in one direction, or successively in both directions, allows us to measure the resistance of the portion of the line-wire included between the fault and each of the stations in connection with the battery. And, as telegraph lines, throughout their length, are constructed with wires of which the nature and diameter are known, it is easy to calculate the length of any portion of the current by the resistance it offers. The indications supplied by such calculation are never absolutely correct; but although merely approximative, they greatly facilitate and abridge the researches necessary to determine the exact point of disturbance."

The observations of M. Gavarret upon the effect of the return-current in long lines, and the method adopted to obviate the same, are of interest to the telegraphist who has not already fully studied the question. The following case, which is of rare occurrence, has not hitherto, we believe, been referred to:—

When several wires terminate at one station, a single conductor is generally used to establish the earth contact both of the negative battery terminal and the receiving instruments at this station. Under these conditions, a defective earth contact may occasion perturbations very troublesome in correspondence.

If, while signals are being received on one receiving instrument, the other instruments are also in position as receptors, the current, as usual, traverses the first; but, instead of subsequently passing to earth, a portion at least of this current may pass through the other receiving instruments, and even through the other wires communicating with the station. The result is, that all the receiving instruments are worked simultaneously; and occasionally, when the earth communication is very defective, the retrogressive current is sufficiently powerful to act upon the receiving instruments at the other station. Too much attention cannot be given to secure the perfection of the earth contacts.

In his observations on the effects of atmospheric electricity upon the wires, M. Gavarret remarks, that the inductive action of a thunder-cloud is occasionally sufficiently powerful to set in action the alarms of a station and the receiving instruments. The effects of the *aurora borealis* of September, 1848, and other phenomena of the same kind, are noticed. During the occurrence of the aurora, says M. Gavarret, the wires are traversed by currents of varying direction and quantities, which render transmission difficult, and at intervals impossible. On certain lines, the accidental tension acquired by the current was sufficient to cause sparks to pass, and *aigrettes* of flame to appear at the points of the lightning conductor. Observers agree in constating the fact, that the power of the currents increase, with the length of the line, and that the phenomena were more apparent upon wires in the direction of the magnetic meridian. On the telegraph lines of Tuscany, Matteucci observed, that the currents were most powerful upon the uppermost wires, becoming weaker, and occasionally disappearing, in the lower wires. The contrary effect, however, was observed at *Saint-Quentin*, in France. At Tulle, Poictiers, and Toulon, it was ascertained, that when one of the extremities of the wire is insulated, the other being in connection with the earth, the accidental currents disappear, but are immediately reproduced when both extremities are led to

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to earth. This latter observation, however, is not in accordance with the experiments of M. Guillemin upon the wire proceeding from Paris, through Mans and Alençon to Lizieux, and thence returning to Paris. The extremities of this line were insulated, and connected by the coil of a galvanometer. During the whole time of the occurrence of the *aurora*, the needle of the galvanometer was deviated, the currents changing in direction every quarter of an hour. M. Gavarret inclines to the belief, that the perturbations occasioned by *auroræ* are due to inductive influence.

The polarisation of earth plates, in their capacity of electrodes, and also by chemical action, is mentioned as an occasional cause of earth currents. In regard to submarine wires, these perturbations have specially been observed upon the Dover and Calais line. The needle of a galvanometer of twenty turns is sometimes deviated to 80°, returning slowly to 0, and deviating to the same extent in the opposite direction. The aërial lines of Auvergne, and those traversing the Atlas mountains, are subject to similar effects, which, in this case, M. Gavarret is inclined to attribute to *thermo-electricity*. In volcanic regions, the natural currents of electricity usually termed earth currents, acquire an unusual degree of power, the reason of which has not hitherto been explained.

Colonial and Foreign Telegraphy.

REPORT OF THE GENERAL SUPERINTENDENT OF ELECTRIC TELEGRAPHS IN THE COLONY OF VICTORIA.

[Continued from page 41.]

Imperfections in the insulation of a section of the Western Line having rendered it necessary to renew the insulators between Warrnambool, Belfast, Portland, and the terminal of the line, near the Glenelg River, I was led into an extended consideration of the subject generally, as to the most perfect form of insulator and the best material for securing the greatest permanency in its effect. I procured five samples of the ordinary earthenware insulators, taken from the posts where they had been exposed to the weather for about three years. On testing these insulators for absorption, I found that one of the number had, in twenty-eight days, increased its weight by nearly three grains. This in itself would have sufficiently explained the couse of the great waste of battery current on the particular section from which the insulators had been taken, as although the defection specially noticeable in the case in point is apparently unimportant, still, when it is considered that in fifty miles of line, there are fifteen hundred insulators, (or 1500 points at which, should there be a defect, the current may diverge from the wire and pass to the posts and the earth) it may readily be understood to what extent even a comparatively small number of defective insulators may affect the efficient working of the communication.

In order more fully to test the qualities of the various descriptions of insulators commonly used, and also their relative value under certain tests, I devised the appliances detailed in the accompanying sketch [*Plate I.*] of which the following is a brief description:—

A.B., figure 1. Is a watertight chamber, six feet high by nineteen inches square, its sides being fitted with plate glass panels, twelve inches square, at about the centre of its height.

C. Is an upright wooden shaft, of the same proportions and in other respects resembling the head of a telegraph post, with insulator and pin as shown in position.

D. Is a water pipe fitted with showering apparatus as shown.

E.E. Are adjustable hinged slides, which may be so arranged as to cause the falling particles of water to strike the top of the post, or the insulator and pin at any desired angle.

F. Is the battery from which the testing current is derived.

G. Is the galvanometer.

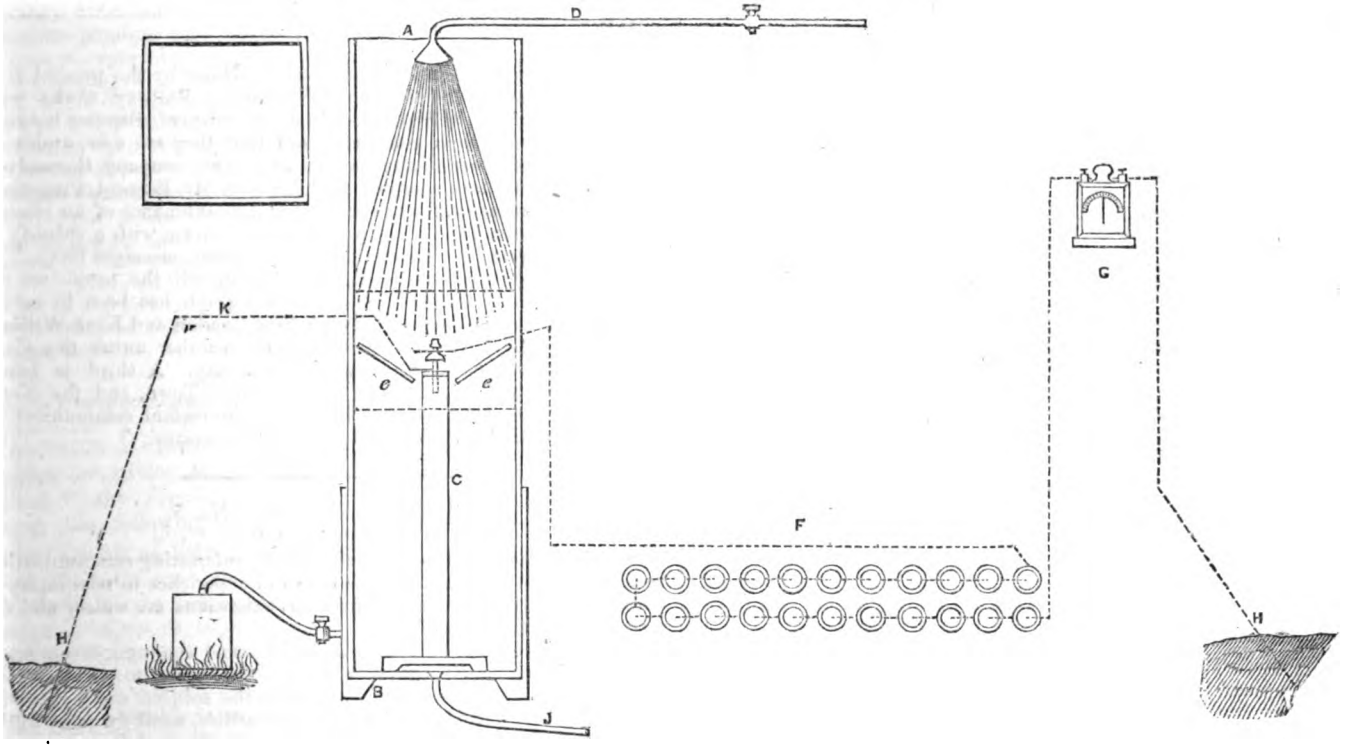
H.H. Are the earth connections; the dotted lines show the course of the circuit, and the interposing insulation at its connection in the inside of the chamber, and *K.* the continuation of the circuit from the insulating pin to the earth.

I. Is a closed metal vessel, partially filled with water, under which a fire is applied; a small pipe conducts the steam so generated to the interior of the chamber, the supply being regulated by a tap cock as shown.

J. Is a waste pipe to carry off the water collected in the bottom of the chamber.

The general arrangements for testing each insulator are as shown; the earth wire is attached to the pin immediately below the insulator and passing thence to the earth; the leading wire from the battery passes clear of all woodwork or substance of any kind directly to the outside of the insulator; the other pole of the battery is conducted through the galvanometer to the earth. The water having been turned on and the hinged slides adjusted so as to give to the falling particles of water a direction similar to that of "driving rain." it will be found

Plate I.



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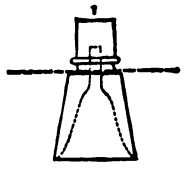
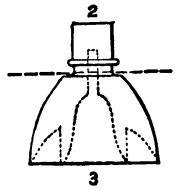
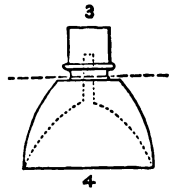
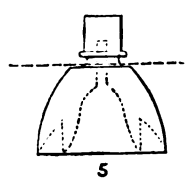
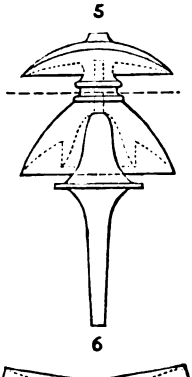
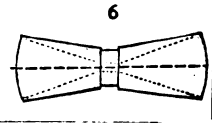
on applying the battery power that any loss from imperfect insulation will soon be apparent on the dial of the galvanometer; the usual duration of each test being about one hour.

The next and most severe test is for aqueous vapour, or fog; the water having been shut off, the tap cock in the pipe leading to the hot water vessel is opened, and the chamber is soon filled with a dense steam, but as it would be contrary to natural conditions to apply any test with the air in the chamber at more than 65° or 70° of temperature, a thermometer is introducod, and when a sufficiently low reading has been observed the battery power is again applied; the result is with an imperfect insulator, instantly noticeable, *as the steam having become partially condensed on both the inside and the outside of the insulator, admits of the conduction of a portion of the current to the earth wire attached to the pin, and so to the earth.*

Table Showing Results of Tests of Insulators as Indicated by the Rain and Fog Application.

Description of Insulator.	Battery Power.	Deflection of Torsion Galvanomter.	Deflection of Henley's Galvanometer.
	Groves.		
No. 1. Single umbrella, (Earthenware.) 	20 cells.	20°	0·50°
No. 2. Double umbrella, (Earthenware.) 	Do.	4°	*Nil.*
No. 3. Single umbrella, (Porcelain.) 	Do.	*Nil.*	Do.
No. 4 Double umbrella, (Porcelain.) 	Do.	Do.	Do.
No. 5. Double umbrella, (Porcelain,) with rain shield and new flange pin. 	Do.	Do.	Do.
No. 6. Double cone, (Earthenware.) 	Do.	5°	Do.

I have tested the insulators Nos. 1 to 6, shown in the accompanying table (Plate II), and the results have been as indicated in the third and fourth columns.

No. 1 being the insulator most commonly in use on the lines in this colony was first tried, when within thirty (30) minutes the torsion galvanometer shewed 20° loss, and a very delicate vertical galvanometer, by "Henley," showed 0·50°; these result were not appreciably increased under the fog test.

No. 2, an improved form of earthenware insulator, showed 4° of loss under all tests.

Nos. 3, 4, and 5 showed no loss under each test, but as Nos. 3 and 4 exhibited a faintly perceptible vibration in the needle, and as No. 5 did not show the same indication, I give the highest degree of merit to the latter, although I believe that its apparent superiority is due in some degree to the new form of pin used; the flange of the pin being only ($\frac{3}{4}$) three quarters of an inch below the lip of the inner hollow section of the insulator, and projecting slightly beyond it protects the interior chamber against the intrusion of the "driving" rain, or rain beating up from the top of the post while forced against it at an angle during the prevalence of storms.

No. 6 showed the most active loss under the fog test, and although proving itself to be superior to No. 1, yet the relative merits of the two insulators would I believe possess little dissimilarity during the fogs, which have so frequently interrupted the working of our coast lines.

In carrying out the tests above detailed, it was of course scarcely possible to secure entirely every condition of atmospheric change to which the insulation of the lines is commonly subjected; but so far as the means referred to would admit, I believe the results to have been obtained with the nearest artificial approach to the usual state of the atmosphere in rainy and foggy weather; the larger per centage of loss might have been shown by employing a more powerful battery, but the force applied being in excess of that which each insulator would, under ordinary circumstances, be required to resist, I did not consider it requisite to use a battery of higher intensity. I purpose making many more experiments on various other descriptions of insulators and insulating material, as soon as present demands upon my time will allow me to pursue the investigation. A supply of the No. 5 insulators and pins has already been contracted for, to be imported from England, and it is expected that they will arrive in time to admit of their being used in the erection of the second wire between Albury and Mount Gambier.

An Electric Telegraph between Durban and Maritzburgh is talked about, and the character of its promoters justifies anticipations of success.—*Natal Mercury.*

The Advices from the Cape of Good Hope by the present mail state that the Cape Town and Wellington Railway works were stopped on the 24th of September in consequence of disputes between the company and their contractor, and that they are now, under an interim judicial order, being carried on by the company themselves. The Government have accepted a tender from Mr. Edward Pickering, the railway contractor, for the erection and maintenance of an electric telegraph between Cape Town and Graham's Town, with a subsidy of £1,500 per annum for conveying all Government messages free. The line is greatly needed, and will pass through all the towns on the main line of posts to the frontier. A telegraph has been in active operation for some time past between East London and King William Town, the capital of British Caffraria. Another unites the Cape capital with the naval depôt at Simon's Bay. A third is being erected between Port Elizabeth and Graham's Town, and the Natal Government are about to put their port in instant communication with Pietermaritzburg, the capital, by similar means.

EARTH CURRENTS.—No. 5.

[Continued from p. 41.]

We will preface our present article with an interesting communication received from a gentleman whose practical experience in telegraphy is extensive, and the results of whose investigations are widely and deservedly appreciated:—

"I have received your paper, and have read the commencement of your article on Earth Currents. I am very glad to see that the Astronomer Royal is about to investigate the subject, and I therefore pass over all that has been stated in your article, until we come to the last paragraph, with regard to the currents observed by you on the wires at Gloster Road, in connection with the earth plates.

"There were but two kinds of currents that could have been visible on your instruments, the first, that occasioned by the iron wire on the poles, and the earth plate, which, if a copper one, would form a battery of one cell—Iron *versus* Zinc.—The moisture from the insulators down the poles, through to the earthplate, forming the required connection

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necessary to give rise to electric currents. Such currents are easily observed on delicate instruments.

"In the case of a copper earth plate, the wire would be found negative to it; in the case of a zinc earth plate the wire would be found positive to that metal; these currents being nothing more or less than galvanic currents between the earth plate and the suspended wires. When the wires were well insulated from dry weather and other causes, it is not improbable that you may have observed a difference between them and the earth, but I much doubt whether the instruments used at Gloster Road had sufficient sensibility to indicate it, as the wires were lower than the roofs of the workshops.

"The results of your experiments, however, will be not only interesting but useful, if, with them you publish a detailed description of the way in which the experiments were tried, so as to enable others to draw their own conclusions from them."

In accordance with the views and wishes entertained by our esteemed correspondent, we will endeavour to place before our readers "*a detailed description of the way in which the experiments were tried. so as to enable others to draw their conclusions from them.*"

In our first article upon the subject of earth currents we fully described the aërial line upon which the experiments were made. In addition to the two miles of copper wires suspended in air we had also at our service one mile of copper wire $\frac{1}{16}$ of an inch in diameter, and an insulating coating of gutta percha of $\frac{1}{8}$ of an inch in thickness, one mile of iron wire of the same dimensions as the copper wire, with the same thickness of coating, and of the same material. Also several miles of wires insulated in gutta percha, india rubber, Wray's compound, Ratcliffe's carbonized gutta percha, and Godfrey's compound.

A battery of 512 elements, which we may here designate as "Muirhead's Daniell's improved battery," was employed for dynamic and static tests, and ;or the dynamic force of currents derived from various metallic substances, such as water pipes, gas pipes, zinc, copper, iron, brass, &c. The effects will be fully detailed hereafter.

The earth communication, especially in regard to the character of the metals employed for what are generally called the "earth plates," is a most important element, as bearing upon the success and efficient working of telegraphs. However pure the earth metals or plates may be at either extremity of the wire, if not exactly of the same nature and quality, dimension and weight, and if they are not embedded in earths of corresponding moisture and purity, capricious currents are created. Pieces of copper wire, from one tenth of a grain to six ounces in weight, were employed as "earth plates" against similar weights of positive and negative elements. The temperature of the water or of the earth in which the "earth plate" is submerged or buried, has also a decided influence upon the potency of the electric current. An earth plate immersed in water at a temperature of 32° Fah. will have a powerful current passing between it and another plate subjected to a temperature of 92° Fah. In the course of our experiments we had the "earth plates" buried in the ground, and the ground moistened or saturated with pure water, lime, salt, and rain water, diluted sulphuric, nitric and muriatic acids, ammonia, &c., we also tried the effect of dry and moist earths, near and distant earths, metallic and earth currents, pure and impure metals, unequal weight of metallic plates, &c. (*To be continued.*)

THE TEREDO AND THE XYLOPHAGA.

Professor Huxley describes the alleged mischief maker in submarine cables as a bivalve shellfish, the *Xylophaga*, closely allied to the *Teredo*. The *Cornhill Magazine* of May, 1861, gives the following rather alarming account of the probable achievements of these formidable worms amongst deep-sea telegraphic cables:—

"Small microscopic animals, and representatives of the ship-worm, boring holes not as large as that which would be made by the finest needle, but by such holes giving admission to external influences, which would be in the highest degree injurious when the interior reached was a metallic wire, and the substance bored through, a coating of gutta-percha, intended to preserve the wire from such contact as would destroy electrical insulation. In this creature, which no one has yet seen, and whose work is only recognized on careful microscopic examination, but whose effect might be felt at a distance of thousands of miles from the seat of injury, is an enemy more dangerous, and causing a difficulty more serious, than any that has yet presented itself, as tending to interfere with the permanent preservation of a submarine telegraph cable laid across the Atlantic. The small boring worm reaches to all known depths, and although at present it may not have eaten into gutta-percha, who can say how soon the taste may arise, which would so seriously interfere with our human contrivances for instantaneous communication."

Having carefully examined, both microscopically and externally, portions of gutta-percha insulated cables, which had been laid for years in sea water, between England and Holland, in the English Channel, and the depths of the Atlantic, we never met with an instance of the gutta-percha having been perforated by marine animals. We also had an opportunity of examining portions of India-rubber covered wires, which had been submerged for years, and with the same result. In November, 1859, we also examined a number of India-rubber valves, which had also been in sea water for years, and without detecting the least manifestation of having been affected by either water or sea animals. The following is a list of the valves so examined:—

"Piece of vulcanized India-rubber, taken out of a vessel trading from Hull to St. Petersburgh, and which had been subjected to the action of sea water for two years.—Received from Messrs. Samuelson and Co., Ship-builders, Hull, Oct. 27, 1859.

"India-rubber valve, taken out of the ship 'John Bowes,' in June, 1856, and had been in use, and subjected to the action of the water, for four years, during which period the vessel ran upwards of 100,000 miles.—Received from Messrs. C. Macintosh, per Messrs. Samuelson and Co.

"Section of India-rubber valve, taken out of the vessel 'John Bowes,' in June, 1856. Had been in use, and subjected to the action of salt water, for four years.—Received from Messrs. Macintosh and Co., per Messrs. Samuelson and Co., Oct. 29, 1859."

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 40.]

Professor Thomson and other experimenters have shown that the quality of the copper exercises an important influence on the conducting power of copper wire; but this question had not been fully developed when we commenced our inquiries; we consequently committed to Dr. Matthiessen the task of elucidating this question further.

We may observe, in the first place, that if the conducting power of silver be assumed at 100; that of copper would be 90; aluminium 34; and iron 13.

Dr. Matthiessen's valuable report will be found in Appendix No. 3. The following is a summary of the results arrived at:—

Table showing the Effect of Admixture of Copper with Specific Quantities of various Substances.

Substances alloyed with pure Copper.	Conducting Power of Alloy, pure Copper being 100.	Temperature Centigrade.
		°
Carbon:		
Copper, with ·05 per cent. of carbon .	77·87	18·3
Sulphur:		
Copper, with 0·18 per cent. of sulphur	92·03	19·4
Phosphorus:		
Copper, with ·18 per cent. of phosphorus	70·34	20·
Do. ·95 do. . .	24·16	22·1
Do. 2· 5 do. . .	7·52	17·5
Arsenic:		
Copper, with traces of arsenic . .	60·08	19·7
Do. 2·8 per cent. of arsenic .	13·66	19·3
Do. 5·4 do. . .	6·42	16·8
Zinc:		
Copper, with traces of zinc . .	88·41	19·0
Do. 1·6 per cent. of zinc .	79·37	16·8
Do. 3·2 do. . .	59·23	10·3
Iron:		
Copper, with ·48 per cent. of iron .	35·92	11·2
Do. 1·06 do. . .	28·01	13·1
Tin:		
Copper, with 1·33 per cent. of tin .	50·44	16·8
Do. 2·52 do. . .	33·93	17·1
Do. 4· 9 do. . .	20·24	14·4
Silver:		
Copper, with 1·22 per cent. of silver .	90·34	20·7
Do. 2·45 do. . .	82·52	19·7
Gold:		
Copper, with 3·5 per cent. of gold .	67·94	18·1
Aluminium:		
Copper, with 10 per cent. of aluminium	12·68	14·0

The addition of a small quantity of lead or of tin (0·1 per cent.) to

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copper containing suboxide obtains a purer metal, and, consequently, improves its conducting power.

The following table shows the conducting power of certain commercial coppers.

Quality of Copper.	Conducting Power.	Temperature Centigrade.	Cause of Diminution of Conducting Power.
Pure copper . .	100 mean	15°5	
Specimen furnished by Mr. Tennant, cut from a piece 1½ tons in weight	98·78	15·5	Traces of silver. *No suboxide of copper.*
American (Lake Superior) . .	92·57	15	Traces of iron, silver (·03 per cent.) and suboxide of copper.
Australian (Burra Burra) . .	88·86	14	Traces of iron and suboxide of copper.
Best selected . .	81·35	14·2	Traces of iron, nickel, antimony, suboxide of copper, &c.
Bright copper wire .	72·22	15·7	Traces of lead, iron, nickel, suboxide of copper, &c.
Tough copper .	71·03	17·3	Traces of lead, iron, nickel, antimony, suboxide of copper, &c.
Russian (Demidorff)	59·34	12·7	Traces of arsenic, iron, nickel, suboxide of copper, &c. The arsenic present may be considered the chief reason of the low conducting power.
Spanish (Rio Tinto)	14·24	14·8	2 per cent. arsenic; traces of lead, iron, nickel, suboxide of copper, &c. The low conducting power is to be attributed to the arsenic present.
Gibraltar Core:			
Specimen, No. 112	90·7	15·5	Traces of lead, suboxide of copper, iron, and antimony.
„ „ 91	89·5	15·5	
„ „ 202	78·2	15·5	Traces of lead, arsenic (very small), iron, nickel, antimony, and suboxide of copper.
„ „ 240	74·4	15·5	

It appears from this table that Rio Tinto copper possesses no better conducting power than iron.

These differences of conducting power are caused by the impurities present in the specimens; the sub-oxide of copper appears to be most injurious, the conducting power of the copper being diminished by it in one case as much as 28 per cent., but there is no known accurate method of determining quantitatively the sub-oxide, and consequently the actual amount present in the specimen in question was not ascertained.

It is scarcely possible to obtain perfectly pure copper, and there is no substance which, added to pure copper, increases its conducting power; but it is of the utmost importance that the purest and best conducting copper should be used in submarine cables. The best way of ensuring this is by contracting for wire of a specified resistance per knot, because then what the copper wants in quality must be made up in quantity. It is, however, preferable to employ pure copper, because impure copper of such a diameter as to have the same conducting capacity, would give rise to greater induction.

The specific resistance of copper and other metals to the galvanic current varies with the temperature of the conductor. In the contract for a telegraph cable, a wire affording a standard of resistance at a specified temperature should therefore be furnished. The resistance at different temperatures will vary with the quality of the metal; and copper is not a good metal for such a standard, because it oxydises easily, and its conductivity varies so rapidly with temperature. The standard should be such that—

I. Its resistance will remain the same, whether it be made of absolutely pure or commercially pure metals; in other words, that such an alloy may be made by any chemist or assayer, and its conducting power will always be the same.

II. That its conducting power will not be altered by the process of annealing.

III. That its conducting power will not vary much with an increase or decrease of temperature.

IV. That the alloy will not alter by exposure to the atmosphere.

Mr. Varley uses for a standard iron wire boiled in oil and enclosed in a soft cement. Messrs. Siemens employ german silver for the purpose, which they compare with their mercury standard at zero centigrade. Dr. Matthiessen, whose experiments are published in the *Philosophical Magazine* for February 1861, considers that the alloy best adapted for a standard of resistance for this purpose is composed of

2 parts by weight of gold,
1 „ „ silver.

And he states that the variation in the conducting power of various specimens of this alloy, made by different persons and in different places, was very small.

With respect to the effect of temperature on this alloy and on copper and other metals generally, Dr. Matthiessen observes, that when a hard-drawn wire is heated to 100° a different conducting power is generally found on cooling; and to obtain concordant results, it is necessary to heat the wire several times; but when once obtained, the values found will remain the same, no matter how often the wire may be heated. Whether by letting the wire remain for a length of time it will gradually assume its original conducting power or not, is a question not yet decided. With annealed wires the same effect takes place, but in a much less degree.

The following table shows the differences in the conducting powers of some metals as compared with that of the alloy, between 0° and 100°, taking the conducting power at 0°=100°.

Silver	28·5 per cent. (annealed).
Copper	29·0 per cent. (annealed).
Gold	28·0 per cent. (annealed).
Mercury	8·7 per cent. (Siemens).
The gold-silver alloy	6·5 per cent. (hard-drawn).
„ „	6·7 per cent. (annealed).
German silver	3·8 per cent. (Siemens).

It would thus appear that, so far as variation of temperature is concerned, the alloys are better adapted for a standard of resistance than the other metals mentioned. Moreover, they do not suffer much from exposure to the atmosphere.

With regard to the expense of the gold silver alloy, the 9 grammes alloy cost, drawn into wire, about £1 4s., but the gold in it is always worth about 15s.; so that the real expense is very small. Care must of course be taken to prevent contact with mercury. The best way to prevent any such accidents is to varnish the wires. In having these alloys made it would be advisable always to have two specimens made by different parties, so as to avoid chances of error.

It will be seen that the experiments above mentioned have cleared the question of the conducting power of copper wire, whether as regards its purity or its area, of all uncertainty, and that the size of a conducting wire necessary to fulfil any given conditions can in future be determined with absolute precision.

In these experiments new methods of testing and new instruments have been employed, which are fully described, and which cannot fail to prove of the highest scientific interest to the theoretical philosopher and to the practical electrician.

(To be continued.)

THE FRENCH TELEGRAPH ON THE FIELD OF BATTLE.

A letter from Chalons, in the *Nord*, describes various improvements in the adaptation of the electric telegraph to the exigencies of active campaigning. The writer says:—"We have had experiments with the telegraph, which succeeded perfectly, and which are very curious. Means have been discovered to establish a portable telegraph. A carriage is constructed for that purpose, in which several cylinders, or enormous bobbins are fixed, round which is rolled a quantity of iron wire of the thickness of a strong cord. This wire is passed by machinery into the box of one of the wheels, and according as the carriage moves the wheel turns and unrolls the wire. A platoon of cavalry soldiers follows. Two men alight at every fifty paces to raise the wire on a slight stick. Four others do the same while the first are moving forward, and raise the wire with a forked pole, which they fix in the ground, and which is fastened with cords strengthened with iron plates. The horses in the carriage go forward at a gallop, and the telegraph is fixed with extraordinary rapidity. The apparatus is worked in the carriage, which serves as an office. When it is intended to return, the action of the cylinders is reversed, and the carriage is turned round preceded by the men, who take down the poles, replace them in a light waggon, and wind up the bobbins."

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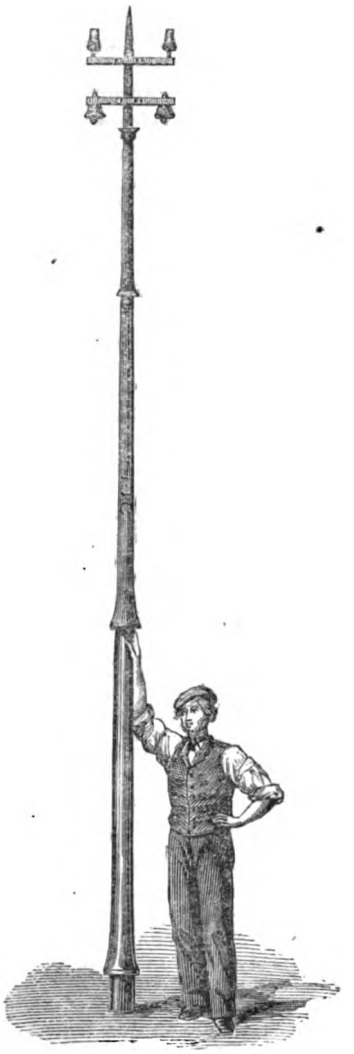

JOBSON AND CO.'S PATENT CAST-IRON TUBULAR TELEGRAPH POSTS.

These iron posts, from their portability, are exceedingly well adapted for Indian and other foreign lines, each part fitting telescopically into the other. Thus they offer great facilities for shipment and can also be easily conveyed, either by hand or by the cheapest mode of conveyance, such as on mules' backs, &c. Being furnished with turned and bored joints, the unskilled labourer of any country can easily put them together. The similar portions of the poles are interchangeable. Should a breakage take place, the part which is destroyed can, therefore, be easily replaced.

This telescopic arrangement of the pole will also be found advantageous in constructing over-house telegraphs; as, after fastening the wires to the insulators, the pole can be raised or lowered at pleasure. Its lightness and its elegant shape also strongly recommend it for roof work. The arrangement for fixing the insulators is admirably contrived. Specimens of these poles may be seen at the extensive factory of the International and Electric Telegraph Company, in Gloster Road, Regent's Park.

THE ADVANTAGE OF OCEAN TELEGRAPHY.

The history of the first attempt to construct and submerge a deep sea line between England and America, as fully detailed in evidence, is a highly interesting one, and by no means devoid of instruction. However brief the triumph, it established a momentous fact, as eternal as the great Atlantic itself, that beneath its tempestuous billows there was laid once upon a time *a way for the "lightning of thunder"*. However heavy the expenditure, the sacrifice, and the amount of dissipated hopes, the Atlantic cable was nevertheless the pioneer in whose gigantic stride others have followed and will again follow, until success shall have crowned the noble and glorious effort.

As an illustration of some of the practical and important services which a system of ocean telegraphy is capable of rendering in cases of emergency, the following interesting statement made in the evidence before the Government Telegraph Committee, will serve to exemplify. It is the evidence of Mr. Saward, the indefatigable secretary of the Atlantic Company. "The fact with regard to the messages were these:—During the Indian rebellion it had been expected that it would have been necessary to recall further troops into England, for the purpose of sending them to India; amongst others an order had been sent to Montreal and Halifax respectively, for the 32nd and 69th regiments to come home. This order was a written one. The state of affairs in India meanwhile took a more favourable turn, and the war department considered that it was no longer necessary that those troops should return; in consequence of which two messages were sent through the Atlantic Telegraph Company's cable, one to Montreal and one to Halifax, giving orders to the commanding officers at those places not to send home those regiments. In answer to the remaining part of your question, (Mr. Varley,) as to the expense saved, of course it would involve the expense of ships to bring those troops home, and subsequently ships to return them to the same place again, the outlay for that purpose certainly could not be estimated at much less than £40,000 to £50,000."

Mr. Newall, the eminent telegraph contractor, in his evidence, further exemplifies the benefit, by repeating a statement made to him by the late Lord Lyons, "that in his (Lord Lyons') opinion, the telegraph cable between Varna and Balaklava lessened the duration of the war by two or three months, by affording the means of rapid communication with the Crimea."

We have thus on record that in two cases of great emergency, ocean telegraphy was the means of saving the public a large amount of treasure, and materially to mitigate the horrors of a protracted and sanguinary war.

At the present time, when the United States of America are engaged in a fierce and bloody strife, and each day fraught with ominous consequence, not only to their own well-being, but also to our commercial and manufacturing interests, and our toiling millions, how deeply deplored is the silence of that once active and peaceful messenger which in the warmth of its first lisping efforts proclaimed—Europe and America are united by Telegraph. Glory to God in the highest; on earth peace, good will towards man.

A comprehensive system of *deep* sea telegraphs would be a most valuable acquisition to the preventive and defensive institutions of the country. It should be laid so deep as not to allow of its destruction by an enemy, so as to enable our military and naval authorities at all times to concentrate their whole forces at a given point, and to regulate the operations of those forces as completely and effectually as if they were under their own eyes.

In the matter of diplomacy, the advantage of rapid communication between distant countries it would be difficult to overrate; and it would be idle to suppose that the commercial world will long neglect the power which ocean telegraphy is capable of conferring on the commercial interests of various countries, by establishing their closer contiguity as regards commercial intelligence and transactions; seeing that by it may be made known in the remote marts of America, India, China, and even Australia, and, *vice versa*, all the fluctuation in the price of marketable commodities, and every bargain in stock or shares within a few minutes of the transaction being closed in either place.

The facility of social intercourse between families and friends permanently or temporarily sojourning in distant lands, which the telegraph would afford, is also a subject which evokes the heartiest wishes for its success.

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PROFESSOR MORSE AND THE ELECTRIC TELEGRAPH.

The following article, in which the origin of the electric telegraph is referred to, is extracted from the *Scientific American* of Nov. 23, 1861:—

PROGRESS OF THE ELECTRIC TELEGRAPH.

The rapid development and extensive application of the electric telegraph seem more like miraculous results than the efforts of man. This discovery confers upon human beings powers almost akin to those possessed by the Omniscient Governor of the universe. With a few plates of platinum and zinc immersed in a dilute acid, a coil of copper wire surrounding an iron bar, and an iron cord stretched upon poles extending along the highway, man can now hold instantaneous converse with his fellow man from one end of a continent to the other. With materials so simple in form and arrangement, such a power seems, indeed, to be superhuman.

The march of invention has been regular in all its cadences; every note is situated in its appropriate place, and all its numbers flow harmoniously.

The invention of the compass for navigating seas enabled the daring mariner to cross unknown oceans and discover new realms. After this came the progression of peoples to the western hemisphere, and the settling of new continents and isles of the sea, thus uniting distant lands by the ties of kindred and commerce. Emigration and trade soon afterward increased in an unprecedented ratio, and the wings of the wind were found all too slow for wafting the merchant's bark across the billows. Some great improvement was then felt to be necessary for increasing commercial facilities, and obtaining more frequent communication with separated friends. As if designed to supply the want, steam power then joined in the march of invention, long voyages were shortened upon the sea, and by the railway distant settlements were more nearly linked together.

But while these improvements undoubtedly brought separated nations and kindreds closer together, they also, at the same time, tended to invite the enterprising to the exploration of new and more distant realms. As the result of this influence, the golden slopes of the Pacific have been peopled in a very few years with many thousands of human beings whose native hearths are on the shores of the Atlantic. It really appears as if the wide earth, through the influence of discoveries in science, had of late years been growing more and more like the abode of one family, for there is scarcely a household in any civilized community which has not a representative in some far-off land, and with whom frequent communication is much desired. And now the telegraph joins in to complete the grand roll of social improvements. The electric cord now spans the continent of the New World, and faster than the earth revolves upon its axis, messages speed along the slender wire between the Atlantic and Pacific cities.

The first scientific suggestion for the construction of the present electric telegraph was made by Ampere, in 1820, and he applied the subtile galvanic coil—the principle upon which the electric-magnetic telegraph is based. In 1837, Professor Morse publicly described his telegraph, which was invented in 1832; but Cook and Wheatstone, of England, first applied the electric telegraph to public business in 1838. In 1844, the first public telegraph line in America was erected between Washington and Baltimore, and since then we may truly assert the whole world has been *electrified* by the invention. It is but seventeen years since the first line of 44 miles was erected, and now there are no less than 56,000 miles of line in operation in America. What an astounding development of the agencies for rapid communication!

But with the triumph of the Pacific, telegraph inventors and telegraph companies must not fold their hands under the supposition that we are at the end of improvement. We take this opportunity to suggest, as we did on a former occasion, that the telegraph is capable of being improved and adapted to a much greater extent than it is, as a substitute for the post-office system. Of course improvements are necessary for increasing the number of messages sent by each machine, and the cost of operation must be greatly reduced. One man can write as fast as a common sounding instrument can receive messages; but this is too slow for the present electric age. Companies for working short independent lines should be formed in every city, and in all thickly populated districts, for introducing the telegraph as a substitute for the "Penny post." The powers of each machine may be greatly increased by modifying its parts, and adapting it for working four, five, or more wires—such a number not being objectionable on short lines. This is an important subject, and it deserves general attention.

Dr. Hamel, in his "Historical Account of the Introduction of Galvanic and Electro-Magnetic Telegraph into England," speaks of Morse and his claims in these terms:—

"After all that had been accomplished before the month of September, 1837, in Europe by Baron Schilling, by Weber and Gauss, by Steinheil, and by Cooke and Wheatstone, it is offensive to observe that in America the painter Morse, who made, on the 4th September, 1837, a poor experiment which he considered 'successful,' is held out as having made an electro-magnetic telegraph before any body in Europe.

"Samuel Finley Breese Morse, born 1791, the eldest of three sons of the late Rev. Jedediah Morse, known for his geographical publications, having a taste for painting, and wishing to study this art, had for that purpose, from 1811 to 1815, been in England (at London and Bristol). At the close of 1829 he came again to Europe, and went by London and Paris to Rome and Naples, thence back to Paris, where he remained about a year to copy paintings in the Louvre. In the Autumn of 1832 he returned from Havre to America.

"On board the packet ship, the Sully, there was, among other passengers, Dr. Charles T. Jackson, of Boston, who had attended in Paris, beside other lectures, those of Pouillet, at the Sorbonne. I call to mind here that Pouillet the year before, in 1831, had made his large electro-magnet, which supported the weight of more than one thousand kilogrammes.

"During the voyage, which lasted from the 8th of October to the 15th of November, Dr. Jackson repeatedly directed the conversation to the subject of electricity and electro-magnetism, which gave occasion to speak about the possibility of electro-magnetic signalising or telegraphing. Dr. Jackson had with him on board a small electro-magnet, which he had bought in Paris, at Pixii Fils, and also a small galvanic battery. He pointed out some means as likely to serve for the purpose mentioned, by sketches, some of which I have seen in Dr. Jackson's pocket-book.

"Arrived at New York, Morse endeavoured to gain his livelihood, as had been the case formerly, by painting portraits.

"He being now always called Professor, most persons believe that he is a professor of natural philosophy, or some other branch of natural science; but this is not the case. In 1835 he got the title of 'Professor of the Literature of the Arts of Design.' It was supposed that he might, in the so-called University of the city of New York, where he was then lodged, lecture on that subject; but he has never, as I know from himself, given one single lecture thereon to pupils.

"As his occupation in painting portraits, ever since his return from Europe in 1832, hardly produced him the means of supporting himself, he, towards the end of 1835, after Baron Schilling's exhibition of his telegraph at Bonn, undertook to try to arrange something for signalising by means of electro-magnetic action, of the possibility of which Dr. Jackson had informed him; but his trials remained without success, because he did not know what was wanted to make a powerful magnet. Two years later, in 1837, when news of the above described doings in Europe reached America (his brother Sidney was editor of a newspaper), he, with the aid of a scientific gentleman, who knew what Professor Henry, then at Princeton, had done with regard to electro-magnets, produced something, which, however, was not at all fit for practical use.

"Professor Henry and Professor Bache, from America, had been, in 1837, in London, and had visited Professor Wheatstone in King's College on the 11th of April, which was six weeks after Mr. Cooke had been with him. During the summer, Professor Wheatstone had signified to some Americans his wish to make an application for a patent at the Patent Office in Washington.

"Morse's idea, then, was not to produce on paper letters or signs representing them, but to have only ten signs for the nine digits and the zero. With these he proposed to express numbers on strips of paper. In an alphabetical vocabulary the words were all numbered. He had an eleventh sign, which served to indicate that the next following signs were really to represent numbers, not words. For each of the signs mentioned, he had a metal type, with a certain number of Λ shaped projections. These types he introduced, one after the other, into a port-rule, by which they were moved forward. The teeth of the types were to lift a lever, by means of which the electric current was allowed to flow through the coils of an electro-magnet, causing it to attract an armature fixed to a moveable vertical lever having at its lower end a pencil, which marked on a strip of

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paper, passing slowly over a roller, zig-zags somewhat like the teeth of a saw.

"To find out afterwards what the groups of zig-zags meant, one had to convert the digits they represented into numbers, and then look into the vocabulary for that number to learn what word was meant by it.

"It was Dr. Leonard D. Gale, Professor of chemistry, living in the same building as Morse, who had instructed him how to make the coils for an electro-magnet; he also procured him the necessary wire, and lent him a proper galvanic battery. Morse made him afterwards his partner, and he, from 1846, held, until lately, a situation in the Patent Office.

"When, at the end of August, 1837, amongst other news from Europe, there came in a German newspaper, the *Neue Würzburger Zeitung*, an account of the 30th June, about Steinheil's doings at Munich, which was translated into a New York paper on the 1st of September, there was, through Morse's influence, on the following day, an article printed, saying that the editors of newspapers in America, who copy such articles from European papers, do not seem to be aware that the electric telegraph which now, as the wonder of the age, seems to have excited in Europe the attention of the scientific public, was an American discovery, and that Professor Morse had conceived it five years ago (1832) on his return from France to America. It was added: 'that Morse had on board the ship made no secret of the general idea, but communicated it freely to his fellow passengers of all nations, who were on the ship.'

"Was not this to make the Americans suppose that Baron Schilling, Weber, Gauss, Steinheil, Cooke, and Wheatstone, might have learnt from Samuel Morse the art of telegraphing by electro-magnetism? As it was also mentioned that Morse had his telegraph then near his lodgings, there came on the same day several curious persons to see 'the wonder of the age.' One of them was Dr. Daubeny, from Oxford, in England. Another was a young gentleman, Alfred Vail, who afterwards became very useful to Morse, for he, with his brother George, made at the Speedwell iron works, near Morristown, in New Jersey, belonging to them, a much better instrument than that invented by Morse. Alfred Vail became, like Dr. Gale, Morse's partner.

"On the day mentioned, the 2nd September, Morse's machine would not mark anything correctly. Great efforts were employed to make it do better, and two days later, on the 4th of September, Morse at last succeeded in getting by it the numbers representing five words and the date, marked. For this were wanted not less than sixty-two zig-zags, and fifteen straight lines on the slip of paper, the figure drawn on it looking somewhat like a saw-blade, with teeth here and there broken out. They represented the following numbers: 215, 36, 2, 58, 112, 04, 01837. Searching in the vocabulary for the meaning of these numbers, it was found that they were to express: 'Successful experiment with telegraph, September 4, 1837.'

"The triumph was immediately sent for publication to the editor of the last mentioned newspaper, and also to Professor Silliman, at Newhaven, the editor of the *American Journal of Science and Arts*, and with it was sent a representation of the wonderful production. It is to be seen on p. 168 of the 23rd volume of the said Silliman's Journal; also in the *London Mechanic's Magazine* of the 10th of February, 1838.

"Morse wrote at that time: 'I assert to be the first proposer and inventor of electro-magnetic telegraphy, namely, on the 19th October, 1832, on board the packet Sully, on my voyage from France to the United States. . . . All telegraphs in Europe are, without one exception, invented later than mine.'

"So spoke the painter Morse in America, after having with the machine which Dr. Gale had assisted him to construct, on the 4th September, 1837, obtained the described poor result. He claimed priority to everything done in Europe in the department of telegraphy. His, for practical purposes, worthless result, he had obtained four weeks after the death of Baron Schilling, who, as we know now, had twenty-seven years before that time (1810), at Dr. Soemerring's, at Munich, got acquainted with the first galvanic telegraph in the world, who, above a dozen years previous, had made at St. Petersburg the first electro-magnetic telegraph, which he had himself two years before exhibited to the meeting of Naturalists at Bonn, where it had so pleased that it was taken immediately to Heidelberg, and half-a-year afterwards from thence to England. Here a telegraph, on the principle first used by Baron Schilling, had, forty-one days before the 4th September, been at work over a mile and a quarter of line in the open air, and through many miles of wire suspended in a building at the terminus of the railroad, near Euston-square, in London; and Schilling had, not long before his decease, at a rope manufactory at St. Petersburg, ordered a submarine cable to be made to unite Cronstadt with the capital through the Gulf of Finland for telegraphic correspondence.

"It is to be regretted that Morse, when, in 1838, he with, and at the expense of, a commercially interested member of Congress, Francis O. J. Smith, came to Europe, wishing to get his apparatus patented in England and in France, was in Paris told that Baron Schilling had invented his electro-magnetic telegraph some time after his return from the frontiers of China, in December 1832, and in 1833. This erroneous statement became for Morse a welcome encouragement to confirm to himself the illfounded priority of October, 1832, and, unfortunately, in most of the works printed since that time, Baron Schilling is stated to have invented his telegraph in 1833.

"We have seen what sort of a telegraph Morse, with the aid of Dr. Gale, had (in 1837) invented. It was a thing quite useless for practical purposes. Alfred Vail, with his brother, very soon after, made for Morse, as I have already mentioned, a better one; and in the course of a good many years, that practically very useful instrument was brought about, which at present goes by the name of Morse's.

"The first telegraph line in England was constructed by Mr. Cooke, from London (Paddington) along the Great Western Railroad to West Drayton, in 1838–39. In 1840, he established the telegraph along the Blackwall railway; and, in 1841, a short line from Queen-street station at Glasgow, through the tunnel to the engine-house at Cowlairs, on the railway to Edinburgh. In 1842–43, the line from West Drayton was continued to Slough. In 1843, two short lines in Ireland and in England were made; but in 1844, one of considerable length, all the way from London to Portsmouth, was done for Government. Some tunnels were also furnished with telegraphs.

"On the 3rd of June, 1844, His Majesty the Emperor Nicholas—being on his way to Her Majesty the Queen at Windsor—saw, at the Paddington station, the working of the telegraph on the line between London and Slough, (which was shown to the Emperor by Mr. Cooke. —Ed.)

"The telegraph on this list served, on the 1st of January, 1845, to apprehend the murderer Tawell, who had come from London to Slough purposely to poison Sarah Hart, and had immediately after returned by the railway train to the capital. This circumstance brought the telegraph at once, all over Great Britain, into great repute and demand.

"In the autumn of that year, the Electric Telegraph Company in London was begun to be established.

"Mr. Cooke and Professor Wheatstone well deserve thanks for having giving the example in applying the electric telegraph to practical use for society at large. I allow myself here to state my feelings of regret, that Baron Schilling did not live to get informed of this application; he died just before it began to take place.

"In America, the first telegraph line, from Washington to Baltimore, was completed in 1844. On the 24th of March in that year, the first short sentence of four words was telegraphed along it. This sentence, in consequence of an invitation from Mr. Morse, was dictated by the daughter of his friend, the chief at the Patent Office, Mr. Ellsworth.* I find this first American original telegram preserved in the Museum of the Historical Society at Hartford, in Connecticut, and have not failed to take an exact copy of it.

"I do not intend at present to say more about the spreading of the telegraph in both hemispheres. My object here has been to give a true and accurate account of the first beginning of the art of telegraphing by means of galvanism and electro-magnetism.

"I have shown that in the month of August in this year, (1859,) it will be half a century since the first galvanic telegraph was made, and I have further demonstrated that it was the Russian Baron Schilling's electro-magnetic telegraph which, without its being known to be his, was brought to London, and caused, since 1838, the establishment of the first practically useful telegraph lines, not only in Great Britain, but in the world.

The small sprout, nursed on the Neva, which had been exhibited on the Rhine, and thence brought to the Thames, grew up here to a mighty tree, the fruit-laden branches of which, along with those from trees grown up since, extend more and more over the lands and seas of the Eastern hemisphere, whilst kindred trees, planted in the Western hemisphere, have covered that part of the world with their branches, some of which will, ere long, be interwoven with those on our side of the globe."

* This Mr. Ellsworth had in May, 1840, allowed himself to return to Morse his original specification, sent in April, 1838, before his departure for England. The pretext was that he might make some explanatory references and add a duplicate drawing. Morse sent in a new specification on the 16th May, 1840. It has been supposed that he introduced into this new document a very important improvement with which he had got acquainted in London, and through which it became possible to telegraph to great distances. I mean the Relays, the linking of fresh circuits to those already exhausted on a long line.

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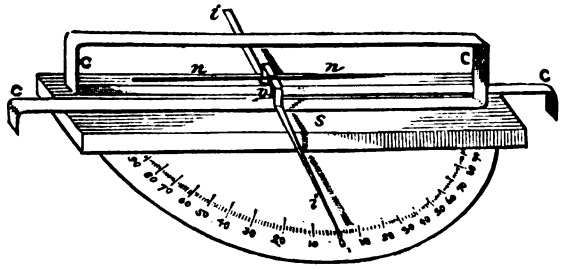
The Student.

VOLTAIC ELECTRICITY—*continued.*

The Galvanometer.—Before we can study the properties of the current generated by our voltaic couple, or by several of the couples connected either by their similar or their contrary poles; it is necessary that we should possess a *galvanometer, i. e.* an instrument to measure the current. It was discovered by Œrsted, that "when a *magnetic* needle is properly poised on its pivot at rest in the magnetic meridian, and a wire arranged over and parallel to the needle, in the same vertical plane, and the ends of the wire made to communicate respectively with the poles of a voltaic battery, the needle will be deflected." The student may repeat the experiment by suspending a magnetized needle horizontally over the conducting wire between the two elements of the couple, by means of a filiment of silk attached to the middle of the needle, and fastened to a bent wire support.

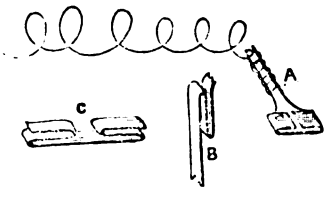
The needle is magnetized by passing over it, longitudinally, in the same direction, the two poles of a small horse-shoe magnet; four or five "strokes" will be sufficient. The north pole of the needle will correspond in position with the south pole of the magnet during magnetization. If the battery circuit be now completed when the needle and the conducting wire are in a parallel direction, the former will be observed to be slightly deflected. By circling the wire *round* the needle, in one or more coils, the deflection is increased; the same effect is produced by augmenting the surface of the battery plates. We have thus the simplest form of galvanometer; the following useful instrument should, however, be constructed for practical use.



A strip of copper, C, a foot or less in length, is bent, as shown in the figure, avoiding contact of the metal at the lower portion of the coil. This may then be heated sufficiently to cause it to adhere to a rectangular piece of gutta percha, S, which forms a stand for the instrument. At p, the projecting point of a needle, thrust through the gutta percha, is the pivot on which the magnetic and indicating needles are poised. The latter, marked i, is constructed of a piece of thin sheet copper, or other metal, and is bent so as to throw its centre of gravity beneath its centre of suspension. The pivot hole may be indicated by pressing the metal with any blunt pointed instrument upon a soft surface, and thus forming a slight depression. Directly over this should now be placed a fragment of sealing wax, or gutta percha as large as a pin's head; this being heated over a lamp allows us readily to attach a magnetic needle, n, at right angles to the indicating needle. Some amount of delicacy in manipulation is necessary in effecting this; not more, however, than every student should possess or acquire. The needles, when once nicely poised, should be carefully guarded from injury. An index, giving the quadrant of a circle on either side of the O sign, may be drawn upon paper or cardboard, and is easily attached to the gutta percha by passing a hot iron over the lower surface of the latter.

Mercury contact Cups.—In order to avoid disturbing the galvanometer when the battery current is passed through the copper strip, it is advisable to immerse the ends of the latter in two small vessels containing mercury; the circuit may then be made by plunging the battery terminals into the same. The cups may be made in a few minutes, as follows:—Two small pieces of gutta percha (a substance which the experimentalist should always have at hand and learn to manipulate) are thrown into boiling water. When softened, the fragments are taken out and placed upon a piece of moist slate or wood, until a portion of their moisture has evaporated; they may then be rolled between the palms of the hands to a globular form, and returned into the boiling water. When again thoroughly softened, they are quickly removed and placed upon the wet slate. By now pressing into the gutta the moistened extremity of a penholder, or uncut pencil, a cavity may be made sufficiently large to contain the amount of mercury required. These cups are very convenient, as they are not heavier or larger than required, and cannot be overturned.

Battery Connections.—Pieces of copper strip bent, as shown below, will be found very useful for the various metallic communications of the battery. The terminal wire of the zinc pole may be attached to

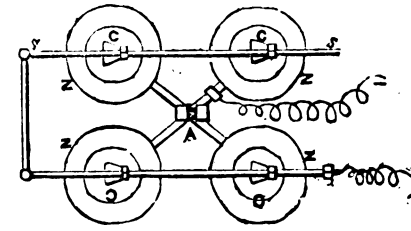


the arm of the cylinder by means of the piece shown at A. The connection B will often be required to unite two strips of metal; that at C enables us to unite four zinc elements together, as will be shown.

Exp. 1.—Arrange the galvanometer, with mercury cups attached, so that the indicating needle remains at O; the magnetized needle will then be in the magnetic meridian. Attach a terminal wire to each element of a couple (the wire should be previously coiled round a pencil to allow of its extension when necessary). Place the ends of the terminal wires upon the tongue; a *very slight* pricking sensation will, perhaps, be experienced. Now plunge them into the mercury cups; the magnetic needle will immediately be deflected, and about 15° or 20° (according to the delicacy of the instrument,) marked on the graduated index.

Exp. 2.—*Tension Arrangement.*—Unite six or more of the couples by their opposite poles, *i. e.*, the zinc of the first with the copper of the second, &c.; attaching the terminal wires to the first copper and the last zinc. Place the ends of the wires upon the tongue; a *sharp* pricking sensation will be felt. The property of the current upon which this physiological effect depends is termed its *tension*. The tension of the current has, therefore, greatly increased by the augmentation of the number of couples united as above. Complete the battery circuit through the galvanometer by means of the mercury cups; *the same deflection will be observed as in the former case.* This shows that the *quantity* of the current passing through the instrument has not been increased.

Exp. 3.—*Quantity Arrangement.*—Unite four couples by their similar poles, as shown below. The copper elements are joined by strips of the metal, *s s s*; the zincs are connected at A, by the joint shown at C in the former cut.



Place the terminal wires of this arrangement upon the tongue; a *very slight* pricking sensation will be experienced—as in the case of the single couple. The *tension* of the current is, in fact, the same in both instances. Complete the circuit with this arrangement, through the galvanometer. The needle will now be far more powerfully deflected than in the former cases; showing that the *quantity* of the current is increased.

Note.—The ordinary galvanometer is not adapted for the accurate measurement of the comparative strength of the voltaic currents—in other words, the deflection produced by *four* couples united, as a quantity arrangement is not the exact multiple by four of the amount of deflection occasioned by *one* couple. This defect of the instrument is due to two causes. When the needle is deflected by one couple, the influence upon it of a *further* quantity of electricity passing through the coil is diminished: 1st, because the directive force of the current, acting at right angles to the conductor, becomes less when the needle is no longer parallel with the latter; and 2nd, because the directive force of the earth's magnetism upon the needle increases when this is at an angle with the magnetic meridian, being greatest when it is at right angles, *i. e.*, pointing east and west. The former defect is remedied in the contrivance termed the *Sine Galvanometer.*

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THE ELECTRICAL ACARUS.

It was in the course of his experiments on electro-crystallization, that that extraordinary insect about which so much public curiosity was at the time expended, was first noticed by Mr. Crosse. The following is his account of the experiment in which it first made its appearance: A wooden frame was constructed, of about two feet in height, consisting of four legs proceeding from a shelf at the bottom, supporting another at the top, and containing a third in the middle. *A B*, Fig. 205, represents two of the four uprights, or legs, issuing from the base *C*, supporting the moveable shelf *D*, which shelf is kept in its place by four pins *E*, passing through the four uprights, and

Fig. 205.

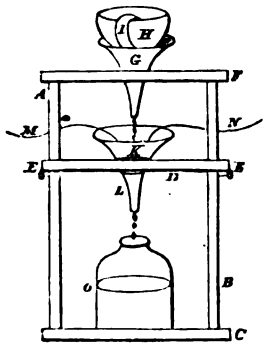
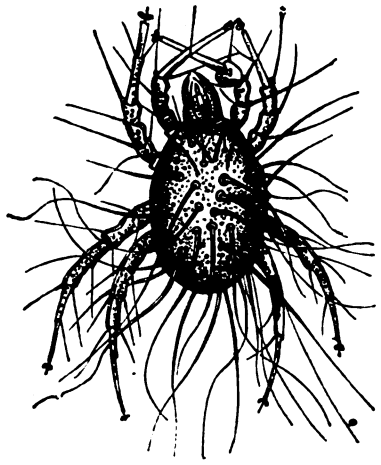


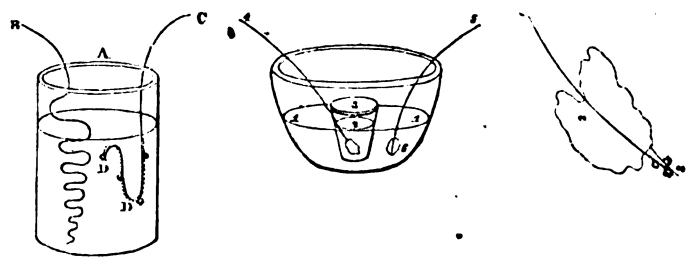
Fig. 206.



may be raised or lowered at pleasure. Each of these shelves was about seven inches square. The upper shelf was pierced with an aperture in which was fixed a funnel of Wedgewood ware, *G*, within which rested a quart basin, on a circular piece of mahogany placed within the funnel. When this basin was filled with fluid, a strip of flannel, wetted with the same, was suspended over the edge of the basin and inside the funnel, which, acting as a syphon, conveyed the fluid out of the basin through the funnel in successive drops. The middle shelf of the frame was likewise pierced with an aperture, in which was fixed a smaller funnel of glass, *L*, containing a piece of somewhat porous red oxide of iron from Vesuvius, *K*, immediately under the dropping of the upper funnel. This stone was kept constantly electrified by means of two platinum wires, *M N*, on either side of it, connected with the poles of a voltaic battery of nineteen pairs of five-inch zinc and copper plates, excited by water only. The lower shelf supported a wide-mouthed bottle to receive the drops as they fell from the second funnel. When the basin was nearly emptied, the fluid was poured back again from the bottle below into the basin above, without disturbing the position of the stone. The fluid with which the basin was filled was made as follows:—A piece of black flint was reduced to powder, having been first exposed to a red heat, and quenched in water. Of this powder, two ounces were taken and fused with six ounces of carbonate of potash: the soluble glass formed was dissolved in boiling water, diluted, and hydrochloric acid added to supersaturation, the object being to form, if possible, crystals of silica at one of the poles of the battery. On the fourteenth day from the commencement of the experiment, Mr. Crosse observed, through a lens, a few small whitish excrescences or nipples, projecting from about the middle of the electrified stone, and nearly under the dropping of the fluid above. On the eighteenth day these projections enlarged, and seven or eight filaments, each of them longer than the excrescence from which it grew, made their appearance on each of the nipples. On the twenty-second day these appearances were more elevated and distinct; and on the twenty-sixth day each figure assumed the form of a *perfect insect*, standing erect on a few bristles which formed its tail. Till this period Mr. Crosse had no notion that these appearances were any other than an incipient mineral formation; but it was not until the twenty-eighth day, when he plainly perceived these little creatures move their legs, that he felt any surprise. When an attempt was made to detach them from the stone, they immediately died; but in a few days they separated themselves, and moved about at pleasure. In the course of a few weeks about a hundred of them made their appearance on the stone: at first, each of them fixed itself for a considerable time in one spot, appearing to feed by suction, but when a ray of light from the sun was directed upon it, it seemed disturbed, and removed itself to the shaded part of the stone. . . . . Mr. Crosse adds, "*I have never ventured an opinion as to the cause of their birth;* and for a very good reason—I was unable to form one. The most simple solution of the problem which occurred to me was, that they arose from *ova* deposited by insects floating in the atmosphere, and that they might possibly be *hatched* by the electric action. I next imagined, as others have done, that they might have originated from the water, and consequently made a close examination of several hundred vessels filled with the same water as that which held in solution the silicate of potassa. In none of these vessels could I perceive the trace of an insect of that description. I likewise closely examined the crevices and most dusty parts of the room with no better success."

In subsequent experiments, this same insect (which it appears is of the genus acarus, but of a species not hitherto observed, and of which a magnified representation is given in Fig. 206) made its appearance in electrified solutions of *nitrate and sulphate of copper, of sulphate of iron, and sulphate of zinc;* also on the wires attached to the poles of a battery working in a concentrated solution of silicate of potassa, as shown in Fig. 207, and in *fluo-silicic acid*, in the arrangement shown in Fig. 208, in which a glass basin is shown partly filled with fluo-silicic acid, to the level 1; 2, a small porous pan made of the same materials as a garden-pot, partly filled with the same acid to the level 2, with an earthen cover, 3, placed upon it to keep out the light, dust, &c. 4, a platinum wire connected with the positive pole of the battery, with the other end plunged into the acid in the pan, and twisted round a piece of common quartz; the platinum wire passes under the cover of the pan; 5, a platinum wire connected with the negative pole of the same battery, with the other end dipping into the basin an inch or two below the fluid, and, as well as the other, twisted round a piece of quartz. After eight months' action, Mr. Crosse perceived two or three insects in their incipient state, appearing on the naked platinum wire at the bottom of the quartz *in the glass basin at the negative pole.* In Fig. 209

Fig. 207. Fig. 208. Fig. 209.



a magnified view is given of the wire, &c., 1 being the platinum wire; 2, the quartz; 3, the incipient insects. At the suggestion of Mr. Crosse, some of these experiments were repeated by the late Mr. Weekes, of Sandwich, by passing currents of electricity through vessels filled with solutions of silicate of potash, under glass receivers inverted over mercury, the greatest possible care being taken to shut out extraneous matter, and in some cases previously filling the receivers with oxygen gas. The general result was, that after an uninterrupted action of upwards of a year, insects made their appearance in every respect perfectly resembling those which occurred in the Broomfield experiments, as the author can testify, having had many opportunities of examining each. In some of Mr. Weekes's later experiments, the acarus made its appearance in solution of ferrocyanuret of potassium. Similar experiments were made by the author, and were continued for upwards of sixteen months. He did not succeed in obtaining the insects *within* the bell jars which covered the solutions undergoing electrolysis, but several, precisely similar to those of Crosse and Weekes, were repeatedly found on, and about, the terminal cells of the battery.—*Noad's Manual of Electricity.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do. B. 7 per cent. till 1862	all	18 to 20	——
20	Do. C. " "	all	9 to 11	——
Stock	Electric Telegraph . .	100	93 to 96	——
20	Red Sea and India Telegraph	all	17½ to 18½	——
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	——
1	Do. registered . . .	all	3/8 to 5/8	——
10	Do. "	all	4 to 6	——
5	United Kingdom Telegraph	2	1d. par.	——
	Mediterranean Extension Tel.	all	4 to 5	——

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PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.—About twenty tons, just arrived, was brought forward at public sale and found ready purchasers for export, viz.:—

	s.	d.
Good genuine	1	3
Inferior reboiled	0	6¾

Since which there has been several inquiries for Export in the inferior reboiled. Fine remains very firm at 1s. 6d.

India Rubber.—	s.	d.	
Fine Para	1	10	per lb.
Buyers at	1	9	
Java and Penang	1	3	no buyers.

The least demand for Export would send the article up several pence per pound.

December 5th, 1861. W. Kirkmann.

Correspondence.

PURIFICATION OF WATER.

Sir,—My attention has been called to an article on the purification of water in the Electrician of the 16th instant. I was much interested with your account of the purifying properties of the alkaline permanganates, but cannot but express to you my surprise that you should have entirely failed to mention my name in connection with the subject. Every single statement made by you respecting the action of the permanganates as purifying agents must have been more or less directly taken from me, since previous to the publication of my experiments demonstrating their application to the disinfection of foul air and water, as well as of solid putridities, no one had ever hinted at the possession of such properties by these substances.

You state it to be your opinion that the purifying effects of the permanganates constitute a valuable gift of science, which is not yet sufficiently appreciated. With such correct sentiments respecting the merits of the discovery, I must conclude that you cannot in common fairness, after being more fully informed on the subject, refuse to acknowledge the just merits of the discoverer.

Independently of what might be due to me, as the first and only original investigator of the hygienic properties of the permanganates, the obligation you are naturally under to aid your readers in taking practical advantage of the discovery, would have been sufficient inducement, I should have thought, for you to state that "Condy's Fluid," which is now within the reach of every one, is a commercial embodiment of the substance whose value you so fully admit. When it is considered that this is the source from which the numerous body of scientific and medical men, who by their every-day use of it have verified and confirmed my observations, have uniformly obtained their supplies of the permanganates, it is obvious that the ordinary run of your readers would thank you more for *not* withholding all allusions to my preparations than for giving them instead an old and not very satisfactory formula, copied from some general chemistry, and which few indeed would care to put to the test. I will make bold to say it is extremely probable, that if you yourself have at any time employed a permanganate for disinfecting purposes it was in the form of "Condy's Fluid" you used it. Why not, therefore, put your readers on as good a footing as yourself in that respect, instead of placing a barrier between them and the very substance you recommend them to use.—I am, Sir, yours obediently, H. B. Condy.

[We beg to refer Mr. Condy to the answer given to a correspondent on this subject in our last impression. We should be sorry to withhold from this gentleman any portion of the credit to which he appears justly entitled. The permanganate solution used in our experiments was not obtained from Mr. Condy, or we should have mentioned the fact in the article referred to, the object of which was to draw attention generally to several purifying agents.—Ed. E.]

INDUCTION ON SUBMARINE CABLES.

Sir.—My attention has for some time been assiduously directed to the production of an improved insulator for submarine telegraphs, believing that *the more perfect the insulator the less the induction, or in other words, the retardation of the rapid transmission of intelligence through a cable.*

In reading the evidence of Admiral Fitzroy in the Government Report I came across some important statements with regard to induction made by Mr. C. W. Siemens, a gentleman, as it appears from his evidence, employed by Her Majesty's Government to test electrically the Malta and Alexandrian cable, and the defunct lines of the Red Sea Telegraph Company. It appears that a superior insulation is a disadvantage, and that my labours were therefore wrongly directed. I quote the statements from the Minutes of Evidence, page 198. I confess that my acquaintance with the interesting and beautiful science of Electricity is rather limited, and the statements of Mr. Siemens, whose experience invests his words with no mean authority, have greatly added to my perplexities in dealing with electrical investigations. The statements are as follows:—

"Captain Galton, the Chairman, to Mr. Siemens.

"The better the insulator the greater the induction almost; is it not so? Generally.

"The more perfect the insulator the greater will be the induction? Yes. You can only have induction strongly developed with a good insulator.

"Admiral Fitzroy: If there were no insulator at all, but a very large wire, what would be the result?

"Mr. Siemens: You would have no circuits; the electricity would return immediately to the other pole of the battery, without going round by America, but being forced in that channel the induction is produced.

"Admiral Fitzroy: Why do you use gutta-percha, was it to insulate the wire as completely as possible?

"Mr. Siemens: There are two causes operating against the spread of the electric current—one is by discharge, by leakage; and the other is by absorption of electricity by induction. One material may allow no escape at all, and yet absorb a large quantity of electricity by induction. Hence there would be great difficulty in speaking through that conductor. Another wire may be so insulated, with gutta-percha for instance, that a great proportion of the current would escape by leakage. That, again, would be a badly insulated wire; but there are those two causes operating quite independently in different materials, and even in the same material.

"Admiral Fitzroy: You do now seek to insulate the wire perfectly by gutta-percha?

"Mr. Siemens: We speak better through a moderate insulated wire; for instance, we speak quicker through a gutta-percha coated wire than we should through an india rubber coated wire, because the induction is less in proportion to the leakage, but that leakage is not sufficient to interrupt rapid communications."

Admiral Fitzroy appears subsequently to have some misgivings as to the correctness of the above statements, for at the bottom of the page I find inserted the following note:—

"*Note.*—[Admiral Fitzroy ventures *to dissent entirely* from the theory of *circuits*, as above-mentioned, and formerly held generally. For reasons unnecessary here, he advocates the *largest* wires, and *most perfect insulation possible.*]"

I trust, sir, that you or some of your scientific readers will afford myself and others engaged in the devising and construction of efficient submarine telegraphs, some information upon so important a subject, so as to avoid needless labour and expense.—Yours truly,

Leeds, 5th December, 1861. P. W. R.

To Correspondents.

"One who wishes to Know."—We cannot do better than to refer you to the Government Report; the capabilities of gutta-percha and india rubber as insulators are fully set forth. You complain that an insulator called "Chatterton's compound," although an "untried" material, has been adopted by Her Majesty's Government in preference to india rubber, and other promising materials. We shall be happy to afford you and others every opportunity to discuss the subject in our columns; and, as the public has to pay to the shareholders in the Red Sea Telegraph Company, "something like £40,000 per annum," for "no value received," it certainly becomes a question of some importance to know how far Her Majesty's Government were justified in adopting a material which you designate as "untried," and which from your experiments has proved a failure as a permanent insulator. You are wrong when you state that the compound consists of simply tar and gutta percha. The ingredients are "gutta percha, Stockholm tar, and resin." We are well aware that tar and resin are only "temporary insulators," and gradually succumb to the action of the electric current. When these are absorbed by the gutta percha, the latter becomes hardened; the insulating sap or moisture is expelled, and an inferior insulating matter takes its place, but when the tar, resin, and gutta percha are thoroughly mixed as a compound, and placed between the layers of a gutta percha core, we are not prepared to offer an opinion as to the ultimate effect. As to your apprehension with respect to a detrimental action taking place between pure masticated india rubber, and the copper conductor *when immersed in water*, or when properly protected in earth or air; we unhesitatingly assert that no such detrimental action takes place. Gutta percha and india rubber, both vegetable gums, are affected in equal degree by the same influences. Upon exposure to air the one becomes brittle, the other soft and sticky. In both the purity and the homogeneousness of the coatings determine the amount of their insulating capacities.

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The Electrician.

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THE TELEGRAPH *versus* FIRE AND THIEVES.

The proposal to unite the fire engine establishments of the metropolis with each other, and with the police stations, by means of the electric wire, is by no means a novel idea; having been first suggested in the year 1857, and repeatedly brought under notice on subsequent occasions. The plan, if carried out, would allow of instantaneous notice being conveyed, simultaneously to every station, of the precise locality of a conflagration, and the degree of danger anticipated from it. This preliminary notice would be followed by instructions for the immediate despatch of the fire engines required at the scene of disaster. The great advantages of such a system need scarcely be insisted upon. By the agency of electricity, time may be saved in a class of contingencies where time is most precious;—in which the loss of a few minutes, by hesitation or mistake, may be attended with the needless sacrifice of human life, and the destruction of a vast amount of the products of human labour. Moreover, the possibility of the false alarms which now continually harass the Brigade, causing engines to arrive from all points when not wanted, would be avoided. If ever the omnipresence of a human directing agency can be of benefit, surely it is when help is required in case of fire!

At the present moment, when electro-telegraphy is an established and universal fact, it is pitiful to observe the dilatory measures generally adopted when a conflagration breaks out amid our crowded habitations. When the fact of the disaster is ascertained, a policeman, or any other observer whose time is not otherwise engaged, hastens to the nearest fire station, which may be a considerable distance from the scene of the fire; and from this station messengers are then sent to all the others. Sometimes at night the reflection of the fire gives the alarm; and this deceptive guide is the only one to indicate to the firemen the spot where their services are required. With these means of intelligence much time is necessarily lost; and often, before the engines have arrived, the premises are entirely destroyed, in other cases the fire has been already subdued; and in others the alarm is found to be unnecessary. Nevertheless, engine after engine continues to arrive; when perhaps other fires may be raging in the neighbourhood from which they have unnecessarily been withdrawn. The telegraph would afford the means of concentrating at any required spot the whole power of the Brigade; and the authorities at the chief fire station in Watling Street, or at the chief police stations in the Old Jewry or Scotland Yard, would be enabled to regulate the movements of their men as accurately as if they were under their own eye; a system which could not fail to result in the saving of much trouble, expense, an immense amount of property, and occasionally of human life. There can be no doubt that in many a disastrous half-hour, occupied in the tardy locomotion of messengers, a greater value has been destroyed in property than would have sufficed for the construction of an efficient and complete telegraphic system, embracing the whole of the metropolis. Of this truth the late fire in Tooley Street affords a ready illustration. Are we to wait for a yet more serious warning before we recognize the expediency of adopting the obvious means at our disposition for securing a comparative degree of safety from the effects of fire?

That which is everybody's interest is commonly said to be the business of nobody; but this should certainly not be the case in regard to the measures for general safety entrusted to the powers that be. It is calculated that the whole of the police stations and fire establishments of the metropolis might be brought into telegraphic communication at an outlay not exceeding £5,000. This sum would weigh lightly in the balance against the yearly value of the property unnecessarily sacrificed to delay in cases of fire.

In working our police system, the means of speedy and secret communication would undoubtedly be of the greatest importance. Police communications, giving the latest news of persons who are "wanted," outlines of crimes committed, and instructions for a watch to be kept on particular persons or places, are we believe *printed* and dispatched at stated intervals during the day. Here again the time which is lost may often be of value to society; as on the other hand it must be to the members of our criminal population. The dial telegraph, now extensively used by private firms, might here be brought into beneficial operation, irrespectively of the advantages to which we have referred. It may be mentioned that a few of the city police stations are already united to the Guildhall by the telegraphic wire. Will not the example thus set be now followed by the chief of our metropolitan police?

UNINSULATED CONDUCTORS.

A vast amount of ingenuity and study has been expended in the problem of transmitting a voltaic current, available for telegraphic purposes, through an uninsulated conductor. The solution of the problem has usually been pursued with considerable enthusiasm, but with small amount of judgment. Thus, while the important fact that such a current may readily, and probably advantageously, be sent through circuits of six miles, or even greater length, by means of an uninsulated wire of moderate size, has been kept in the background; the most visionary projects for working uninsulated wires of hundreds or even thousands of miles in length, and submerged in water, by currents of the tension of a single cell, have been brought prominently forward. In several of these plans the materials of the conducting wires constitute the elements of the voltaic arrangement to be employed in signalling. In what the uneducated stigmatize as "theory" or in hypothesis based upon insufficient grounds, this appears a very pretty system. It completely ignores, however, the known laws of the transmission of electricity in linear conductors, and also the fact that voltaic action is accompanied by the more or less rapid corrosion of the positive element of a galvanic couple.

Nevertheless several systems have been proposed, which, whatever may be their shortcomings in practice, are at least worthy of careful consideration and study. In these the same principle prevails, viz.: the passage through a sufficient conductor of a current of low tension; the comparative resistances to earth and wire conduction being calculated to ensure the transmission through the entire circuit of a considerable portion of the electricity entering into the same. The resistance to earth conduction is also augmented by various means; such as bringing the uninsulated conducting wire to earth at some distance from the earth plate of the battery, by facilitating the formation of an oxide upon the wire, &c. These plans are, in general, specially suggested for application to submarine wires; but would appear to be applicable in a greater degree to land circuits. There is no doubt but that overland communication might be effected by employing a series of short circuits of uninsulated wire with battery relays; the wire being laid in earth with suitable precautions, which we shall hereafter have occasion to refer to. How far this

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system might present advantages, in point of economy and simplicity, is a point which must remain undecided, until it is submitted to the test of practical trial. The necessity of a perfectly efficient insulation for submarine wires of any considerable length is not at the present moment open to question; but there is some reason to believe that the insulation from the earth of overland wires may ultimately be dispensed with. The discussion of this question may be of vast practical moment; and we will, therefore, in a future number, bring to the notice of our readers the experiments which at various times have been made to furnish *data* upon this matter.

THE DEEP SEA TELEGRAPH OF THE FUTURE.

[From a Correspondent.]

The casualties to which submarine telegraphy is liable are various, such as severance by anchors, attrition against rocks, prevalence of kinks, oxidation and consequent destruction of the iron sheathing, the alleged devastation of the teredo, and other marine animals, in hempen covered cables, and injury by lightning. All cables are likely to be affected by such causes to a degree more or less. There is another class, fraught with by far the greatest danger, and which have materially affected the permanent and successful construction and submersion of submarine cables, belonging chiefly to the nature and character of the insulating material employed. The existence of impurities, air holes, and cavities, and the eccentricity of conductor, either the result of imperfect manufacture or high temperature to which the cable is subjected on transition, the elongation of the cable in the course of paying out, and the return of the elongated sheathing forcing the copper from the core, and often both from the protective sheathing itself, are also sources of considerable risks in the operation of laying down submarine lines.

In the general evidence to the Report, it is to the latter class of causes that the failure of deep sea telegraphs are more immediately and generally ascribed. We are informed that "the failures of the most extensive lines of submarine electric telegraphs, which have hitherto been but too frequently experienced, have become manifest almost invariably by a gradual decrease of insulation;" and it is further observed that "in repairing these lines it has generally been found that the gutta percha has become disintegrated by the electrolytic action of the current employed in working the line, in places where the thickness of insulating material had been *originally below the average*, owing to some mechanical injury, or, more frequently, owing to *a cavity* in the material forced into by the water, or to an *eccentric* position of the conductor (Appendix, 455).

With respect to the elongation, it is observed (page 8):—"It is yet a subject of conjecture what the nature of that fault can be—evidently the fault was perceptible during the time that the cable had a strain thrown upon it (the section of the Red Sea between Cossier and Suakin), but disappeared when this faulty place had securely reached the bottom, and was relieved of the strain. This proves, I think, that there was in the gutta percha some fissures or faulty place, which, by a slight extension of the cable, could admit the water near enough to the conductor to produce defective insulation, but which closed again by the elasticity of the gutta percha, until by the continued action of the electric current a partial disintegration of the protecting film of insulating medium was produced. Another, and a larger fault, appeared in the next section from Suakin to Aden during its submersion, at seven miles distance from Aden, but which was rectified; that was a fault in the gutta percha, produced evidently on board ship."

Another witness observes (4,431):—"I think from what I have seen lately of faults in gutta percha, that my confidence is entirely gone. I would never undertake to lay down a cable laid in gutta percha, the faults have been so great and so frequent that I have not the least confidence in it." And this witness had laid in all upwards of 19,000 miles of such cables!

The Report is not less decided upon the point of the inapplicability of ordinary gutta percha for the purpose of deep sea telegraphy, from its liability to be injured by the inevitable high temperature to which it would be subjected in ships or the tropics. Gutta percha should in no case be exposed to heat, the exact amount of which cannot be defined and regulated. This material is not, therefore, a desirable one for cables, which have to be conveyed through or laid in the tropics.

Professor Wheatstone observes (page 285):—"That india rubber surpasses all other materials in the smallness of the amount of its inductive discharge, and the perfectness of its insulation. In the former respect a coating of india rubber is fully equal to a coating of ordinary gutta percha of double its thickness; and, in the latter respect, its comparative advantage is still greater." (P. 286): "The imperfectness of insulation increases with the temperature, but there is a great difference in the rate of increase according to the insulating substance, which is made the subject of experiment. Silver's india rubber maintains an insulation almost perfect up to 92°, while gutta percha is considerably affected." *Ibid.* "India rubber preserves nearly the same amount of discharge from 32° to 165° F."

Professor Miller states (p. 340):—"The absorption of water by caoutchouc is always sensible; this absorption, however, reaches only to a small depth, and does not destroy, or in any wise impair, the insulating power of that portion of the caoutchouc which is beneath the moistened layer."

Mr. Latimer Clark's remarks in his Report, with respect to the high state of perfection to which the manufacture of india rubber cores has arrived (p. 329):—"Messrs. Silver and Co. sent a great many miles of masticated india rubber wire prepared by their process for examination, and a reference to the tables of insulation (Appendix 6) will show the high perfection of their insulation, and at the same time the low specific inductivity of the material. Caoutchouc is very apt to attract moisture to its surface, which then conducts electricity, and it is probable that the insulation of the material is very much better even than the table of insulation would lead one to suppose. All the specimens were uniformly excellent. The induction of india rubber was to that of percha of similar size as 44·7 to 22·7. It is singular that the amount of this induction did not increase with the higher temperature."

The following comparative measurement of the inductive charge and discharge on india rubber and ordinary gutta percha covered wire, are extracted from the tables of measurements above referred to by Mr. Clarke. Thickness of coating in both instances, 6-32 inch. Diameter of copper, 2-32 inch. Battery power, 128 elements:—

	Temperatures.						
	32	42	52	62	72	82	92
	°	°	°	°	°	°	°
India rubber covered wire:							
Charge...	9·4	9·4	10·2	9·5	9·6	10·	9·7
Discharge	9·5	9·5	10·2	9·4	9·6	10·	9·6
Gutta percha covered wire:							
Charge	14·8	14·8	15·6	15·4	16·2	17·3	21·3
Discharge ...	14·2	14·8	15·5	14·9	15·2	*15·5	*17·2

The same wires tested for loss of insulation on dynamic electricity battery power, 512 elements:—

	Temperatures.						
	32	42	52	62	72	82	92
	°	°	°	°	°	°	°
India rubber covered wire:							
Loss of insulation.	0·	0·	0·	0·	12·	0·	0·
Gutta percha covered wire:							
Loss of insulation.	1·8	1·4	6·16	7·16	15·7	25·25	30·6

* * Reduced by leakage.

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Mr. Siemens states (p. 9):—"I have seen lately some tests of india rubber coated wire which certainly speaks very much in favour of that substance; and it may be a question whether it could be advantageously applied in many cases, either separately or in conjunction with gutta percha. It would certainly be free from many of the difficulties under which gutta percha has hitherto laboured. *It would be free from cavities, and it would not be affected by heat and elongation of the conductor in disturbing the centre.*" (*Ibid.*): "I found that gutta percha did not hold the charge well for any length of time, owing, as appears to me, to its greater facility of decomposition by the current, whereas indla rubber alone holds the charge for a considerable time—for hours."

Mr. W. H. Preece, the engineer of the Channel Islands telegraphs, observes, in speaking of the india rubber covered cable manufactured according to the old process forming a part of the system, "It was manufactured in 1852, and remained coiled in a yard during the whole of that summer and autumn, and was eventually submerged in its present position in the early part of 1853, where it has remained undisturbed to the present day (producing a specimen), during which it has 'worked well.'"

Mr. Fleeming Jenkin says (p. 137):—"I made an experiment upon that knot (india rubber) with respect to the discharge, and I found that the charge or quantity of electricity in that knot was only three-fourths of the charge upon the standard knot of gutta percha. This is but one experiment, and I should not wish to attach too much importance to it, but if it be confirmed that the inductive capacity of the two materials is at all in that ratio, it would give the india rubber a very considerable advantage."

The question naturally arises, what is then to become of deep sea telegraphy? Are we to deprive ourselves of its advantages because of the declared inapplicability of one material? The answer is readily found in the production of a superior insulating material, and the devising of sheathing better adapted for its protection and for submersion in great depths.

It is, in our opinion, essential that the insulating medium should possess the following qualities, &c.:—

It should be free from impurities.

It should be free from cavities and air-holes.

It should maintain, under all conditions, concentricity of conductor.

It should be perfectly homogeneous.

It should be capable of being easily and effectually joined.

It should not be affected by high temperature.

It should not be deteriorated by elongation.

It should not be impaired by immersion in water.

It should have the highest insulating power.

It should have the lowest inductive capacity, and

It should be of light specific gravity, and small in bulk, for the facility of manipulation and transport.

How far we have succeeded in securing a material possessing those essential requirements let the following statements bearing upon the subject, extracted from the Government Report, determine. After mentioning that the first land telegraphs were in every respect analogous to submarine cables, and that in tunnels more especially humidity prevented the use of open wire, the report proceeds to say (p. 13): That "to this difficulty submarine telegraphy is deeply indebted for the progress it has made. It was in overcoming this obstacle that india rubber was first successfully employed; and it is remarkable that the first really efficient insulating substance that was used should, after falling entirely into disuse, be now again brought forward. As in the case of the copper for the conductor, so india rubber appeared almost specially intended for the purpose of insulation. The substance possesses *insulating qualities* of the *highest order*. It is *tough*, highly *elastic*, of less *specific gravity* than water, easily manipulated, extremely *durable under water, nearly impervious to moisture*, except superficially, and *not extremely costly*." (P. 14): "The experiments in a very high temperature showed that whilst india rubber withstood a temperature of 200°. Gutta percha covered wire was entirely spoiled at a temperature a little over 122°. P. 15: "As regards the effect of temperature, the absorption with a pressure of 20,000 per square inch, was for gutta percha *six times* as much at a temperature of 75° as at a temperature of 45°; for india rubber *two and a half times* as much, and for Wray's compound *seven times* as much." P. 21: "There appears to be less difference in india rubber when subjected and not subjected to pressure than in any other of the materials experimented on." P. 22: "That *india rubber surpasses all other materials in the smallness of the amount of its inductive discharge, and the perfectness of its insulation.* In the former respect a *coating of india rubber* is fully equal to a coating of ordinary gutta percha of *double* its thickness." P. 25: "Caoutchouc is always much *more free from impurity* than gutta percha, *its properties* are therefore *far more constant*, and the little experience which has been obtained as to *its durability*, shows that there is no ground of *apprehension on that score*."

In the "summary of principles which should govern the construction and laying of submarine telegraphs," the committee further report, p. 33: "Of the *materials* which have been submitted to us, the *best by far is india rubber*." India rubber surpasses all other materials in the smallness of the amount of its inductive discharge, and the perfection of its insulation. A coating of india rubber is fully equal to a coating of the gutta percha hitherto in use of double its thickness." P. 34: "India rubber . . not perceptibly affected by any ordinary increase of temperature, but increase of temperature has a very decided influence in diminishing the insulation of gutta percha."

With respect to the slight absorption of water the report says, "it does not appear that this absorption is to be feared as a cause of deterioration in submarine cables."

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 54.]

2. *The Insulating Covering.*

The first land telegraphs that were constructed were in every respect analogous to submarine cables, and the wires were, indeed, frequently laid across rivers and canals, beneath the water.

In the earlier experiments, which were confined to buildings, or sheltered positions, the copper wires were insulated by a covering of cotton or silk, laid spirally over the wire; the cotton was subsequently steeped in some resinous substance to protect it from damp, and ultimately the wires so prepared were immersed in a body of pitch, or resin, and laid in wooden troughs, or iron pipes. As many as ten wires were thus laid along the Blackwall Railway in a wrought-iron gas pipe, two inches in diameter. In such pipes the wires were carried under ground or water.

It was, however, found almost impossible to maintain sufficient insulation by such means. In some places water penetrated through the pipe, in others the sun damaged the resin, and generally the resinous substance used, gradually decomposed, or absorbed moisture. There are, however, still working in the Primrose Hill tunnel nine wires insulated by means of cotton and pitchy compounds inclosed in a lead tube, which have been down for fourteen years. Moreover, although the utmost care was devoted to the subject, it was found impracticable to lay down any great length without serious faults occurring in the construction, and the system was hopelessly abandoned, and entirely superseded by the open air wires. Covered wires, however, were indispensable for leading into stations, under bridges, and especially through tunnels, where the constant humidity prevented the use of open wires, consequently the greatest difficulty that has had to be overcome with the overland lines has been the passage through long tunnels, and to this difficulty submarine telegraphy is deeply indebted for the progress it has made. It was in overcoming this obstacle that india rubber was first successfully employed, and it is remarkable, that the first really efficient insulating substance that was used, should, after falling entirely into disuse, be now again brought forward.

As in the case of copper for the conductor, so india rubber or caoutchouc almost specially intended for the purpose of insulation. This substance possesses insulating qualities of the highest order. It is tough, highly elastic, of less specific gravity than water, easily

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manipulated, extremely durable under water, nearly impervious to moisture, except superficially, and not excessively costly, and it appeared on its first introduction as though nothing further could be desired. One of the first and most important requirements in any insulating substance that may be adopted is that it should offer facilities for making the numerous joints required, either for the repair of lines when laid down, or in their first construction. For this purpose india rubber appeared also well adapted. If, instantly after being cut, two surfaces of this material are again brought into contact, they unite almost as perfectly as though no separation had taken place; moreover, being soluble in naptha with a slight increase of temperature, two surfaces may be hermetically united by warming them and slightly moistening them with this material. The copper wire, previously covered with cotton and shellac, was covered by thin strips of masticated india rubber, wound spirally on the wire, each turn overlapping the last, and several coatings were thus put on the wire, the union of the india rubber being secured by slightly moistening it with naphtha. A degree of insulation, infinitely superior to anything that had been before obtained was the first result, and the problem on which so much time and money had been expended seemed to be definitely and perfectly solved, and the new material came into rapid use. It required, however, but a very short experience to dispel all the hopes that had been raised. This gum resin, like all others of a similar character, slowly burns, or oxydizes, even in contact with the air only, and in the dark; but in the light, and especially where exposed openly to the weather and the sunlight, the oxydation goes on with fatal rapidity; the wires hung out of doors soon became useless; the oxydized gum assumes a thick gummy character, and soon falls away from the wire. The union made with naphtha was found not to be durable; and after a short time, even in unexposed situations, the rubber was found loose upon the wire. Attempts were made to preserve it by enclosing it in grooved boards, and thus protecting it from the air, but this in dry situations was found to be of but little avail; and though in wet tunnels it was found to be more durable, yet here also it was ultimately abandoned. In other cases, the india rubber assumed a liquid form from decomposition, and simply left the wire by flowing away from it.

To avoid these difficulties, gutta percha was proposed. Gutta percha is, when perfectly pure, and at moderate temperatures, a remarkably good insulator, and capable of being kneaded and drawn solidly on the wire through dies, which avoids the joint which is necessary with india rubber laid on in strips.

Some difficulties, however, rendered its first introduction not so successful as that of india rubber. In the first attempts, the covering, which was single only, was not efficiently put on, and contained air holes, and other defects. This was partly due to imperfections in the manufacture, but more particularly to the bad quality of the gum itself, which comes to this country mixed with a very large proportion of impurities, so large, indeed, that but a very small per centage of the gum imported is fit for the manufacture of covered wire at all. In addition to the impurities already existing, fine sawdust and ground wood were mixed with the gum. It was also combined with sulphur, with the bad result already detailed under our last head. It was also found liable to oxydation when exposed, though this appeared to be avoided by covering it with Stockholm tar, and immersing it in water, or otherwise protecting it from the air; it is not liable to assume the liquid form, but the making of an efficient joint offered several difficulties, as it was absolutely necessary for this purpose to remelt the material. These joints gave rise originally to a great number of faults, which, together with the general impurity of the gum itself, and the imperfect manufacture, were the principal drawbacks to the more rapid introduction of gutta percha. Gutta percha, even moderately pure, however, has many advantages, and fell into hands far too enterprising and persevering to be rapidly abandoned. The manufacturers devoted themselves to the perfection of their machinery, sorted the gum with the most elaborate care, and soon produced a tolerably pure material. Improved methods of making the joints were introduced, fine ribbons of thin gutta percha being used instead of kneading over the joint with a mass of material; and above all, the system was introduced of covering the copper wire with several independent layers of thin material, instead of one thick layer; the occurrence of air holes, or defects from minute fibres left in the material were thus to a great extent obviated. The greatest care was, moreover, bestowed at the manufactory itself on the testing of the wire during the process of manufacture. Coincident with these improvements in manufacture, the Telegraph Companies endeavoured to protect the material from oxydation by covering the wires with tape and Stockholm tar, and enclosing them in wooden grooves, or covering them with yarn and tar, and laying them in underground pipes, the material being thus found to be tolerably durable, especially when immersed in water. In all cases, however, where these precautions were not taken, the wires rapidly became useless, and many hundreds of miles have thus been abandoned, while, on the other hand, with these precautions many lines which have been some years in use are still in good working order. It is, however, only since the commencement of our inquiry that the perfectly pure material has been produced in sufficient quantity to be practically useful; and that the high insulating properties of the gum in its pure state have been appreciated.

Professor Hofmann appears to have been the first to point out the cause of the decay of gutta percha and india rubber; and at the commencement of our inquiry we requested Professor Miller to undertake the chemical investigation of this question. His report will be found in Appendix, No. 4.

It appears that pure gutta percha is a hydro-carbon, containing of—

Carbon	88·96
Hydrogen	11·04
	100·00

The gutta percha of commerce is mixed with resin, vegetable fibre, moisture, &c.; the moisture is mechanically diffused through the mass, influencing its pliability and toughness. Commercial gutta percha will remain unchanged for months in air, provided light be excluded, and provided the temperature be not raised very high, and it will remain unaltered for years in water, especially when coated with Stockholm tar, and when light is excluded. Alternate exposure to moisture and dryness, on the other hand, particularly if the sun's light has access to it, is rapidly destructive of gutta percha. All the deteriorated portions of gutta percha examined by Professor Miller were found to have undergone change from oxidation. The evidence we have taken shows that it has occasionally been injured in the sea by animals.

Caoutchouc consists of a hydro-carbon of definite composition, mixed with a small quantity of resin. It is liable to deterioration by exposure to the action of oxygen in the presence of solar light, but the gum is less rapidly injured if exposed to these influences in the native state than if it has been previously masticated. When subjected to the action of air excluded from light it does not experience any marked change even during very long periods. Further particulars will be found in Professor Miller's report.

We have made numerous experiments upon the effect of temperature and hydrostatic pressure on both gutta percha and caoutchouc. Such experiments occupy a very considerable time, and are otherwise difficult to perform. The general results appear to be that temperature has a very marked effect on, gutta percha, but that pressure appears to consolidate the material, and improve the insulation of both gutta percha and india rubber.

The effect of temperature on the insulation of several insulating substances which we experimented on is shown in the tables of experiments in Appendix No. 6.

The results may be briefly stated as follows:—With gutta percha in ordinary use for submarine cables, the insulation at 72° was not one-half as good, and at 92° not one-fourth as good as it was at 52°; and at 52° it was not one-third as good as at 32°. Perfectly pure gutta percha was a far superior insulator, and suffered little loss of insulation until it attained a temperature of between 72° and 92°. India-rubber and Wray's compound, which are very far superior as insulators to the gutta percha which has been ordinarily in use, exhibit very little loss of insulating power until they attain temperatures far above 92°.

The experiments in a very high temperature showed that whilst india-rubber withstood a temperature of 200°, and Wray's compound a temperature of 152°, gutta percha covered wire was entirely spoiled at temperature a little over 122°. At a temperature of from 90° to 100° Fahrenheit gutta percha will not change its shape; but at higher temperatures a conducting wire covered uniformly with gutta percha will easily become eccentric by the mere process of coiling. Gutta percha covered wire should in no case be exposed to heat, the exact amount of which cannot be defined and regulated. This material is therefore not a desirable one for cables which have to be conveyed through or laid in the tropics, unless means be found for ensuring that the cable be maintained at a low temperature.

When immersed, gutta percha, india-rubber, Wray's compound, and Chatterton's compound absorb a portion of water. Professor Miller's experiments, in which gutta percha and india rubber, were subjected to pressure of three tons per square inch for a period of six weeks, show that the absorption of water by gutta percha is very slight, almost *nil*, in sea water. In fresh water it is appreciable, but

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trifling. The absorption of water by caoutchouc is always sensible, the surface being rendered white and opaque, owing to the amount of water that has penetrated into the substance. The absorption, however, only reaches to a small depth, and does not destroy or in any impair the insulating power of that portion of the caoutchouc which is beneath the moistened layer. The white aspect disappears as the substance is allowed to dry. The amount of absorption is dependent upon the extent of surface exposed to the water. The insulation of the specimens of gutta percha and of masticated india rubber, experimented upon by Professor Miller, was in no way impaired by immersion under pressure, but the results with virgin india rubber were not equally satisfactory. Messrs. Siemens' experiments on the immersion in water of gutta percha, india rubber, and Wray's compound, give the following results:—

The materials examined absorb water more rapidly from pure water than from sea water, and more rapidly from sea water than from concentrated brine. In gutta percha this difference is very decided, the absorption being about three times as great in sea water, and five times as great in pure water as in brine. Caoutchouc absorbs water somewhat less rapidly than gutta percha at 39° Fahr., which may be taken for the temperature of the deep sea. Wray's mixture absorbs at the same rate from sea water as from pure water, that rate being nearly equal to that of gutta percha, at the lower temperature of 39° Fahr.

Increase of temperature affects the rate of absorption by gutta percha moderately with sea water, that rate being little more than doubled for an increase from 39° to 120° Fahr. In pure water the absorption at an increased temperature is greater. Caoutchouc absorbs from brine at about the same rate at 39° and at 120° Fahr. From sea water it absorbs at double the rate at 120°, and in pure water the rate of absorption is as much as eight times greater at 120° than at 39° Fahr. With Wray's mixture, the rate of absorption from sea water is not materially influenced by temperature; but in pure water the rate of absorption increases in a very extraordinary ratio with increase of temperature, being about 16 times greater at 120° than at 39° Fahr. Both caoutchouc and Wray's mixture change colour and lose firmness when exposed for many days to pure water of 120° Fahr.

The thickness of the sheets of material employed, affects the absorption in a much higher ratio than can be accounted for by the simple increase of surface. The absorption of water by the thicker sheets appears to stop short at a limit which is rapidly exceeded by the thin sheets. The conductivity of these materials appears not to be materially affected by the absorption of two to three per cent. of water, which may be taken for a limit that will not be exceeded in sea water and at ordinary temperatures.

Increase of pressure within the limits of 50 lbs. per square inch does not affect the rate of absorption materially. The rate is somewhat higher under a vacuum, owing probably to the absence of condensed air upon the surface.

Mr. Fairburn (Appendix No. 5) made some experiments at Manchester under a pressure of 20,000 lbs. per square inch, equivalent to a depth of 8·72 miles. At that pressure a sheet of gutta percha 1-16th inch thick absorbed ·05 per cent. of its weight of pure water, after an exposure of 65 hours. A further exposure of 23 hours did not produce any further absorption. A pressure of 5,900 lbs. per square inch, continued for a period of 450 hours, on a sheet of gutta percha 1-16th inch thick, produced an absorption of ·2 per cent. of pure water; whilst with a piece of gutta percha 1 inch thick the absorption in a similar period was only ·08 per cent. Mr. Fairburn's experiments also included trials of the absorption of india-rubber, Chatterton's compound, Wray's mixture, and other substances. As regards the effect of temperature the absorption with a pressure of 20,000 lbs. per square inch was for gutta percha six times as much at a temperature of 75° as at a temperature of 45°, for india rubber two and a half times as much, and for Wray's compound seven times as much.

Mr. Fairburn found that in pressures of 20,000 lbs. per square inch, the insulation was improved by consolidation, and that the bulk of the material was reduced.

(To be continued.)

EXPERIMENTS ON CAOUTCHOUC.

The caoutchouc of commerce is, like gutta, not a pure vegetable principle, and consists of a hydrocarbon of definite composition, mixed with a small quantity of resin, the amount of which varies in different specimens.

The following are the results of my analysis of a sample of pure unmanufactured Para rubber, compared with a sample of good sheet masticated or manufactured rubber.

	Virgin.	Masticated.
Pure caoutchouc	96·6	96·64
Moisture	1·3	0·82
Resin	1·8	2·06
Ash	0·3	0·48
	100·0	100·00

Or, deducting moisture and ash, its elementary composition gave —

	Virgin.	Masticated.
Carbon	85·82	85·53
Hydrogen	11·11	12·06
Oxygen	3·07	2·41
	100·00	100·00

CHEMICAL EXPERIMENTS ON COMMERCIAL GUTTA PERCHA.

BY DR. MILLER, F.R.S.

The gutta percha of commerce is not a pure proximate vegetable principle, but it consists chiefly of a hydro carbon, which may for brevity be termed *pure gutta*, or simply gutta, mixed with a product of its oxidation which is in a form of a soft resin, amounting to about 15 per cent. in the best commercial samples.

The following is the composition of a piece of ordinary good commercial gutta percha, taken from a piece of new cable.

Pure gutta	79·70
Soft resin	15·10
Vegetable fibre	2·18
Moisture	2·50
Ash	0·52
	100·00

The moisture reported in this analysis is mechanically diffused through the mass of the gutta percha, and seems to have some influence upon its pliability and toughness. 100 parts of the commercial sample when dried at 212° till it ceased to lose weight, deducting the ashes, contained—

Carbon	84·66
Hydrogen	11·15
Oxygen	4·19
	100·00

This gutta percha softens and liquifies by a heat of 212°. It is soluble, with the exception of a few flocculi of fibrous matter, in benzole, in bisulphide of carbon, and in ether. Alcohol dissolves none of the pure gutta, but extracts a portion of the soft resin. This resin is an oxidized compound, probably in a transitional condition to a higher stage of oxidation. I found it to consist of—

Carbon	76·15
Hydrogen	11·16
Oxygen	12·09
	100·00

The true gutta was extracted nearly pure from this sample by dissolving it in benzol, filtering and adding alcohol, when a coagulum of pure gutta was obtained, which was found to consist of—

Carbon	87·22
Hydrogen	12·04
Oxygen	0·74
	100·00

The presence of the small quantity of oxygen in this case was due to a little of the resin which still adhered to the precipitated mass of gutta.

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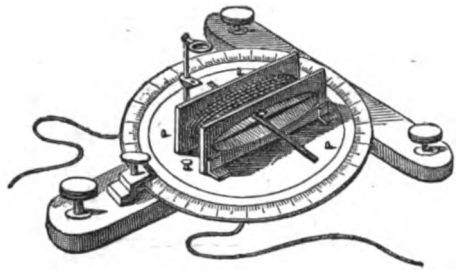
GALVANOMETERS.

The *Sine* galvanometer, represented below, consists of a single magnetized needle surrounded with a coil which is moveable on its axis; it acts on the principle that *the intensity of the current varies as the sine of the angle of deflection*, and is applicable rather to the determination of the intensity of strong currents, than to the detection of weak ones. The instrument is placed in the magnetic meridian, and when the needle is deflected by the current, the coil is turned until it again



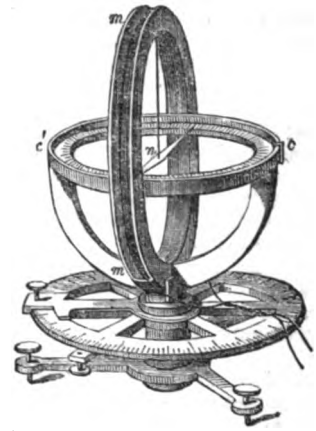
coincides with the new direction of the needle, the exact parallellism of the needle and coil, being determined with the aid of a lens. The number of degrees which it was necessary to turn the coil from the zero point to adjust it to the new position of the needle, is read off on the graduated scale surrounding the coil. This is the exact measurement of the angle which the needle forms with the magnetic meridian, and also of the intensity of the current, by which the needle has been deviated; but this is also equal to the horizontal force of terrestial magnetism, in virtue of which, the needle tends to return to the magnetic meridian, and this being equal to the *sine of the angle of deflection*, the intensity of the current is of course the same, and its value may be determined by reference to a table of natural sines.

Professor Callan's sine galvanometer (*Phil. Mag. N. S.* vol. vii. p. 73), consists of a mahogany circle 2 feet 4 inches in diameter, and nearly 2 inches thick, in the circumfexence of which is turned a groove ½ an inch wide and 3½ inches deep; of seven concentric coils of ⅛ of an inch copper wire in the groove, and well insulated from each other; of a strong frame in which the circle is moveable on an axis and always kept in a vertical position; and of a compass-box, which, by means of a slide 3 feet long, and at right angles to the circle at its centre, may be moved in a direction perpendicular to the circle to the distance of 3 feet from it, so that the centre of the needle, which is a bar 5⅛ inches long, will always be in the axis of the coil, and and that the line joining the N. and S. points of the compass-box will be always parallel to the horizontal diameter of the mahogany circle and coil. From this description it is evident that (no matter where the compass-box is placed on the slide) the needle is parallel to the mahogany circle and coil, or perpendicular to their axis whenever it points to 0°. Hence, if a voltaic current sent through the coil deflect the needle, and if the circle and coil be turned round so as to follow the needle until it points to 0°, the needle, no matter where it may be placed on the slide, will then be parallel to the coil and perpendicular to its axis.

The effective part of the earth's magnetism in impelling the needle to the magnetic meridian is also exerted in the direction of a perpendicular to the needle or of the axis of the coil, but opposite to that in which the magnetic force of the coil acts. Since the needle is kept at rest by these two forces acting in opposite directions, they must be equal. But the effective part of the earth's magnetism in impelling the needle to the magnetic meridian varies at the sine of the angle which it makes with the meridian; therefore the magnetic power of the current flowing through the coil also varies as the sine of the angle of the needle, when it points to 0°, makes with the magnetic meridian. If the connection with the battery be broken, the needle will immediately return to the magnetic meridian. The graduated circle of the compass-box will give the number of degrees the needle was deflected from the magnetic meridian. For measuring the angle of deviation, a graduated circle of about 13 inches in diameter is used; it is attached to the upper part of the mahogany circle, and at right angles to it, and to the axis about which it is moveable. When the current is sent through 7 coils, the deflection is so great, that only very feeble currents can be measured on the sine galvanometer. When the needle is in the centre of the coil, this galvanometer, used as a sine instrument, large as is its diameter, is incapable of measuring the power of a current produced by a single circle of the cast-iron battery: but by sliding the compass-box and needle 2 or 3 feet from the coil, a current of very great power can be measured.

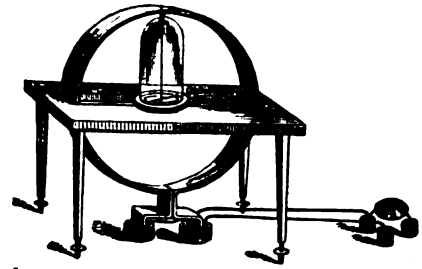
The *Tangent* galvanometer (Figs. 188 and 189) consists of a large circle or hoop of copper ribbon covered with silk, fixed vertically upon a graduated circle, exactly in the centre of which is placed, either by suspension by a silk thread, or on a cap resting on a pivot, a very short but intensely magnetized needle. The hoop is placed exactly in the magnetic meridian, and when the current is transmitted

Fig. 188.



through it, the needle deviates, and the force of the current is proportional *to the tangent of the angle of the needle's declination*, whence the name given to the instrument. The needle is provided transversely with a long light copper needle by means of which the angle is measured. This instrument is not so sensitive as the sine galvanometer, but is applicable to currents of very high intensity. The tangent of the angle of deflection may be learned, without calculation, by reference to the table of natural tangents. An instrument, called the

Fig. 189.



differential galvanometer, has been used for the determination of the relative force of two currents. It consists of a galvanometer with two perfectly similar wires wound round the same frame; now, if two currents of precisely the same intensity be sent in opposite directions through these wires, the needle will obviously remain at zero; but if one current be more powerful than the other, the needle will move, indicating the strongest current, and showing the amplitude of the deviation, by how much, the strongest current exceeds the weakest.—*From "Noad's Electricity."*

CALCULATED PRESSURE UPON A SUBMARINE CABLE AT VARIOUS DEPTHS.

1 ton	2,240 lbs. on circular inch.
,,	1,759 lbs. on square inch.
,,	586 fathoms of water—1,172 yards.
2 tons	4,480 lbs. on circular inch.
,,	3,518 lbs. on square inch.
,,	1,172 fathoms of water—1 m. 644 yards.
3 tons	6,720 lbs. on circular inch.
,,	5,277 lbs. on square inch
,,	1,759 fathoms of water—1 m. 1,758 yards.
4 tons	8,960 lbs. on circular inch.
,,	7,037 lbs. on square inch.
,,	2,345 fathoms of water—2 m. 1,170 yards.
5 tons	11,200 lbs. on circular inch.
,,	8,996 lbs. on square inch.
,,	2,932 fathoms of water—3 m. 584 yards.
6 tons	13,440 lbs. on circular inch.
,,	10,555 lbs. on square inch.
,,	3,518 fathoms of water 3 m. 1,756 yards.

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MANUFACTURE OF BOTTLE INDIA RUBBER.

The caoutchouc, as it is called, exudes in the form of a milky sap from the tree. In order to collect it in large quantities the natives make incisions in the bark, and receive it in vessels in which it is prevented from solidifying by agitating and shaking them. Clay forms are then made in the shape of bottles, or any other object which it is desired to re-produce in caoutchouc, and over these the liquid gum is spread in repeated layers until the requisite thickness is obtained. They are then dried in the smoke, which confers on the india rubber the dark colour which we usually see it possess in a solid state. And the clay model being then broken, is easily extracted, leaving the flexible bottle or shoe.

THE EXTINCTION OF FIRES.

Mr. J. F. Bateman, president of the Mechanical Section of the British Association at Manchester, made the following communication respecting the best mode of extinguishing fires. He (Mr. Bateman) had hoped that a paper would have been read on this subject by Mr. Rose, of the Manchester Fire Brigade, but as that gentleman had been called away by the illness of a relative, he (Mr. Bateman) thought it right that the proceedings of the section should not terminate without some observations being made on the subject. Nothing could have been much worse than the arrangements made for the extinction of fires some fifteen years ago, and nothing could be much worse than the state of things which existed at the present day in the city of London. In most large towns, as Manchester and Glasgow, for instance, where the supply of water had been taken into the hands of the Corporation, the best preparations had been made for the extinction of fires. But in London, the fire engines and the brigade were maintained by contributions from the different insurance companies, and it was therefore evident that their interest only lay in preventing the destruction of property that was insured. It was clear this was a state of things which ought not to exist in this country. Some twelve or fifteen years ago he turned his attention to the subject of the extinction of fires. The old wooden plug or fire cock was then generally in use, and it still continued in use in some parts of the country. Mr. Bateman described the construction of the branch stand pipe, with which he had replaced the old plugs in Manchester and other towns, and stated that as a general rule these stand pipes had been found sufficient without the use of fire-engines. He also explained the principle upon which the water pipes were laid down in Manchester; so that within reach of nearly every block of valuable buildings in Manchester and the neighbourhood there were from two to three sources of water supply, and ten or twelve fire-cocks within a hundred yards. Then came the question of pressure. It was popularly supposed that water could be thrown to any height; but this was not so. About 80 or 90 feet was the greatest height water could be thrown by a fire engine. In Manchester during the day, when the demand on the water supply was greatest, the pressure was diminished about six feet per mile. The highest mills in Manchester were from forty feet to sixty feet, and experiments had been made to show that at the low pressure the highest stand pipes would throw ninety feet. With the smallest stand pipes, four inches in diameter, the height varied from thirty-three feet to ninety feet. Experiments had been made in the Town's Yard, which had shown that with large engines, requiring thirty men to work them, with constant relays, no advantage was gained over the stand pipes, which required but two men to work them. He now wished to draw their attention to the arrangements which ought to exist for the extinction of fires. If once the flames had obtained a hold of the building it was utterly impossible to extinguish it, and all the water poured on became at once converted into steam, and thus increased the draught, and only served to add fury to the flames. All the fire brigade could then do was to prevent the fire from spreading to the surrounding buildings. And yet, if a bucket of water had been applied at the right time, the fire might have been prevented. Therefore, what ought to be done was, that in every district a fireman should be stationed within a distance of not more than 100 yards from the scene of a possible fire. Manchester was divided into seventeen districts, in each of which districts a waterman was stationed, whose duty it was to make himself master of his own district. Of these seventeen men ten belonged to the fire brigade, which consisted altogether of fifty men. Now, if in addition to these watermen other members of the brigade were stationed in various districts, each man furnished with a small hand cart, a stand pipe, and as much hose as he could carry in his hand cart, and was also enabled to communicate by telegraph with the central stations, the frequent recurrence of serious fires would be in a great measure prevented. He did not think there would be either any difficulty or any great expense in carrying out this arrangement. Under present arrangements a fire might occur two miles from the principal stations. A person would consequently have to run that distance to give information, ten minutes would be occupied in this way, it would take ten minutes more to get the horses out, and some further time would be consumed in arranging the hose. Perhaps during the time thus lost the fire would have made such headway as to be beyond the power of extinguishing. He was satisfied that if the plan he proposed were carried out it would pay for itself in many ways. Mr. W. Smith said he thought too much attention could not be bestowed upon the way in which water was thrown on to a fire. He had seen water thrown in such thin jets that it was at once converted into steam. He thought it should be thrown as much as possible in dashes, in a body. Mr. Adamson suggested that instead of the water being thrown so much to the top of a burning building, it should be thrown on at the bottom, so that the steam should assist in extinguishing the flames above. Dr. Robinson called attention to the beautiful system of telegraphing in use in America in the case of fires.

The Student.

VOLTAIC ELECTRICITY—*continued.*

In 1820, almost immediately after the discovery by Œrsted of the action of a current of electricity upon the magnetic needle, Arago, acting upon the theory suggested by Ampère in explanation of this action, found that by placing a steel needle within a glass tube, and making a few turns of the conducting wire round the latter, the needle was converted into a permanent magnet by the passage of the current.*

A few years later, Sturgeon constructed the first electro-magnet as follows:—He bent a piece of strong iron wire in the form of a horse-shoe, and, having varnished it, twisted a piece of copper wire round it, the turns, only sixteen in number, being separate from each other. Upon passing a powerful voltaic current through the coiled wire, he found that the iron horse-shoe was converted into a temporary *magnet*.

A great improvement upon this form of electro-magnet was effected by Professor Henry, by employing wire insulated with silk thread wound in close coils round a piece of *soft* iron bent in the form of the letter U. This principle was further extended by coiling the wire in successive layers upon the arms of the magnet, according to the plan embodied in the following instructions:—

The *Electro-Magnet.* A rod of soft iron, bent to the required form, with an *armature*, or flat piece of iron, to apply to the poles of the magnet, may be obtained of the smith; one-third or half-inch rod will be found a convenient thickness. The power of the magnet, however, is augmented, *ceteris paribus*, by increasing the diameter of the iron. The next thing for the student to consider is the thickness of the wire to be used for the coils of the magnet. Wire, insulated with silk or cotton, is now readiiy to be obtained in commerce, and will answer the purpose better than any the student might prepare. If very fine wire be employed, a great length will be necessary; and the magnet thus constructed will be best excited by a current from a number of couples associated for tension. We recommend the student to construct, in the first instance, a "quantity electro-magnet" with wire of moderate thickness, eighteen or twenty guage, coiled in three or four layers upon each arm of the magnet. With this, a quantity current, from twelve or more of the small couples united by their similar poles, will be found powerfully to develop the magnetic action. A single couple of zinc and copper plates of large size will, however, be more convenient and efficacious than the compound battery; such a couple, constructed so as to occupy the least space possible, will presently be described, as it forms a very useful source of a large supply of electricity of low tension.

In order to avoid the chance of failure in coiling the electro-magnet, we will describe the operation somewhat minutely. The first turn of the wire, at the extremity of one of the arms of the magnet, is tied with strong thread, to prevent its becoming uncoiled while the remainder of the wire is being wound. The coil is then made closely and evenly as far as the commencement of the bend in the iron. From this point a second layer of wire is wound over the first; and a third layer may then be coiled over the second helix. We have now again arrived at the commencement of the bend in the iron; the three coils being completed upon one of the arms of the magnet. The wire

* To repeat this experiment successfully, a current of very considerable quantity is required.

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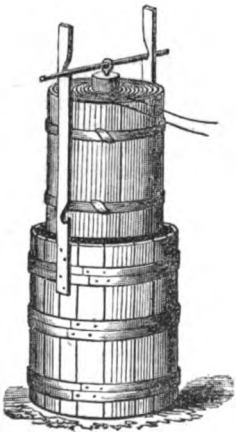
is then led *between* the arms of the magnet, and coiled in the *opposite* direction upon the uncovered arm. If we suppose the iron bar to be now straightened, the wire would be wound upon it in the *same* direction throughout; the change of direction in coiling being consequent upon the change of direction in the iron bar by approximating its extremities. These coils are made on the second arm precisely as those upon the first; the last turn of the wire being kept in position by tying with thread.

Very little observation will suffice to show that, with the same electro magnet, the amount of magnetic force developed increases with the quantity of the current. This, however, is the case only up to a certain point, which indicates the maximum conducting power of the wire for electricity of the tension given. At this point the *resistance* of the wire in the circuit is said to prevent the passage of any further quantity of electricity of this tension. The term resistance will be understood as expressing the limit of conductivity in a wire or other body. The resistance of a wire, other things being equal, is dependent upon its diameter and length. Thus a short length of stout wire, composed of copper, which is a good conductor, offers comparatively a very small amount of resistance to the passage of electricity. A wire of the same length and diameter, composed of iron, which is an inferior conductor, would offer seven times the amount of resistance; *i. e.* with a current of the same tension, would allow of the passage of only one seventh part of the quantity of electricity which could be conducted by the copper wire. *Tension* is the property of electricity which enables it to overcome resistance. Voltaic electricity must necessarily, in all cases, possess some degree of tension; since otherwise it could not become manifested in the form of a current through a wire offering a specific amount of resistance. In its highest state of tension, viz., as lightning, electricity is enabled to overcome the resistance offered by miles of so imperfect a conductor as moist air. It will be seen that the tension of voltaic electricity must in all cases be comparatively small in degree; its quantity is, however, very great our small voltaic couple producing in one minute more than would be sufficient to charge a thunder cloud. The increase of tension in the voltaic current enables us to force a greater quantity of electricity through a conducting wire. This may readily be exemplified with a galvanometer constructed with very fine wire. We have seen with our students' galvanometer, that the deflection of the needle increased with the quantity of electricity generated in this battery. With the fine wire galvanometer, employed for practical purposes, a fraction only of the electricity generated by one couple can pass through the wire; the resistance of the latter being very considerable. It is useless, therefore, to increase the quantity of electricity at the same degree of tension. In uniting two couples by their opposite poles, the tension of the current is doubled; and, with this arrangement, twice the quantity of electricity may be forced through the wire of the galvanometer, producing a corresponding deflection of the needle. The same increase of effect, by augmenting the tension of the current, will be observed in the case of the electro-magnet, when the resistance of the wire coils prevents the passage of the total quantity of electricity generated in the battery.

For the construction of bar electro-magnets, the above instructions will suffice; the winding of the wire offering no difficulty or liability to mistake.



The quantity Couple or Calorimotor.—The simplest method of constructing a voltaic couple of large surface is as follows;—Procure a sheet of zinc and one of copper of equal size,—say one yard in length by six inches in breadth. Place the copper upon a flat surface, and cover it with a piece of cloth or doubled canvas of equal size. Upon this place the zinc, and cover the latter with a similar piece of cloth or canvas. Tie the strips together, thus arranged, with twine; they may then, with the help of a hammer, be rolled into a cylindrical form upon a piece of wood. The couple is then placed in a jar of sufficient size, containing very dilute sulphuric acid; and conducting wires may be attached to the elements by means of the copper connecting joints previously described. When the ends of the conducting wire are rubbed together, sparks will be perceived; fine iron wire may be heated to redness, or even to whiteness, in the circuit, and the quantity of electro-magnet is powerfully affected by the current produced by this couple. A battery of similar construction, represented below, was made at the Royal Institution, under the direction of Mr. Pepys. The plates of this couple were sixty feet long by two feet wide; they were kept asunder by horse-hair ropes—this material resisting the action of the acid employed—and suspended over a tub containing about fifty gallons of dilute sulphuric acid. The heating action of this battery was very intense.

COMMENTS ON DR. HAMEL'S "HISTORICAL ACCOUNT OF THE INTRODUCTION OF THE GALVANIC AND ELECTRO-MAGNETIC TELEGRAPH" INTO ENGLAND.

[Our readers, having seen several extracts from Dr. Hamel's interesting account of the introduction of Telegraphy into England and America, in our previous numbers, will be pleased with the following clear and forcible statements, by such an authority as Mr. William Fothergill Cooke.]

The "Historical Account of the Introduction of the Galvanic and Electro-Magnetic Telegraph," lately published in England, by Dr. Hamel, of St. Petersburgh, is a work of permanent historical value.

It has been written with the declared object of claiming for his countryman, Baron Schilling, and for his country, Russia, the honour of the first realization of the idea of an electric telegraph. Dr. Hamel might have made a like, and much stronger claim in behalf of Dr. Soemmering, of Munich; for he proves him to have invented and made in 1809 the first galvanic telegraph on record; and it appears to have been this invention which stimulated Schilling to enter upon the same field of experiment. But neither Soemmering or Schilling succeeded, in the long period of twenty-seven years, between 1809 and 1836, in giving to their ideas a practical character; and no part of the inventions or apparatus of either of those pioneers in electric telegraphy was ever employed in England.

As the sight of Soemmering's telegraph of 1809 stimulated Baron Schilling to invent his needle telegraph, between 1825 and 1830; so the sight of a model of Schilling's telegraph, in February 1836, stimulated another mind to devote itself to the same object. But it is submitted that the facts which Dr. Hamel has collected with so much patient research, and narrated with such clearness and accuracy, do not at all bear out his claim on behalf of Baron Schilling.

He describes (at page 40), a telegraphic instrument invented by Baron Schilling, about 1830; and tracks Baron Schilling and his instruments to a meeting of the German naturalists, held in 1835, at Bonn. At this meeting, he says, Baron Schilling "exhibited his telegraph before the section of Natural Philosophy and Chemistry; over which George Wilhelm Muncke, Professor of Natural Philosophy at the University of Heidelberg, presided. Muncke was much pleased with Schilling's instrument, and he determined at once to get one for exhibition at his lectures."—(Pp. 43, 44.)

Accordingly, Professor Muncke exhibited in his lecture-room at Heidelburg a copy of Schilling's instrument. This instrument Dr. Hamel has lately found there, after a lapse of twenty-three years (p. 43), and he proceeds to show that W. F. Cooke saw the same in operation in March, 1836.

Dr. Hamel devotes ten pages from 47 to 57, to "details from his own investigation," "carried on at Hiedelberg recently," relating to the march of the electro-telegraph idea, from its experimental application, in Muncke's lecture-room at Heidelburg in 1836, to its realization on the London and Birmingham Railway in 1837. He states that in the beginning of March, 1836, William Fothergill Cooke,

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an English officer, on leave of absence from India, was residing at Heidelberg, engaged in studying anatomy, and in modelling his dissections for the museum of his father, who was Professor of Medicine at the University of Durham. This young soldier and amateur anatomist, accidentally heard of the telegraph models in Professor Muncke's possession, and became "curious to see the telegraphing out of one room into another." "When Mr. Cooke saw the telegraphing, and was told the instrument could work through great distances, the idea struck him that such a thing might be useful in England, particularly in tunnels along the railroads." His prompt activity in realizing this idea are then traced by Dr. Hamel down to the date of the first English patent in June 1837.

But how does this make out Dr. Hamel's claim in favour of Baron Schilling? *No part of the Baron's invention*, (which is accurately detailed by Dr. Hamel at page 40,) *has even been in use in England.*

It is true that Muncke's model exhibited to Mr. Cooke Ampère's long known idea of giving signals by a magnetic needle under the influence of a voltaic current,* but this idea had already been made widely known, and had reached England at an earlier date.

Dr. Hamel alleges—

First.—That Cooke introduced the electric telegraph into England, immediately after seeing at Heidelberg Muncke's copy of Schilling's telegraph.

Herein the testimony of Dr. Hamel agrees with that of Mr. Cooke, except that Mr. Cooke erroneously ascribed the origin of Muncke's model to Gauss.—(Hamel, p. 50.)

Secondly.—Dr. Hamel asserts that it was merely a copy of Schilling's telegraph that Cooke so introduced.

Mr. Cooke's volumes, above noticed, refute this statement; for they contain drawings of Muncke's model and of his own first telegraph. To these drawings Dr. Hamel, who had recently found Muncke's original models at Heidelberg, refers at page 54 as correct.† Moreover, Mr. Hoppner (a gentleman named by Dr. Hamel at page 45) bore evidence to the accuracy of the drawings before Sir I. Brunel and Professor Daniell, in an arbitration Cooke *v.* Wheatstone, in 1841; the papers relating to which are contained in Cooke's 2nd volume.

At pages 40 and 41, Dr. Hamel describes Baron Schilling's telegraph in these words:—"He now used for it the deflection of the needle, which he placed within the multiplier of Scweigger, horizontally, on a light vertical axle hanging on a silken thread, and bearing a circular disc of paper coloured differently on each side. To make the needle move steadily, and to prevent oscillations, Schilling had fixed to the lower extremity of its axle a thin platina plate, and immersed it in a cup of mercury."

This description is in exact agreement with that given by Mr. Cooke (vol. 2, pp. 14 and 15) as follows:—

"Professor Muncke's experiment was at that time the only one upon the subject that I had seen or heard of. It showed that electric currents being conveyed by wires to a distance could be there caused to deflect magnetic needles and thereby to give signals. It was, in a word, a hint at the application of electricity to telegraphic purposes, but nothing more—for it provided no means of applying that power to practical uses. His apparatus consisted of two instruments for giving signals by a single needle, placed in different rooms, with a battery belonging to each; copper wires being extended between these two termini. The signals given were a cross and a straight line, marked on the opposite sides of a disc of card fixed on a straw, at the end of which a magnetic needle was suspended horizontally in galvanometer coils by a silk thread. The effect of this arrangement was, that if a current was transmitted from either battery, when the opposite ends of the wires were in connexion with the distant telegraphic apparatus, either the cross would be there exhibited by the motion of the needle one way, or the line by its motion the other way, according to the direction of the current. The apparatus was worked by moving the ends of the wires backwards and forwards between the battery and the coils."

Dr. Hamel's third point is, that Muncke's copy of Schilling's telegraph was imported by Cooke into England, and there adopted. This seems to be the Doctor's chief error. For as regards the form and arrangement of the instrument as described by himself, or others, *no one detail of it has ever been in use in England.* And although in exhibiting signals by means of the deflection of a magnetic needle, Schilling* had applied a suggestion of Ampère's, which is also embodied in the English telegraph, yet Schilling's telegraph did not contain any one of those practical arrangements which gave to the first English telegraph its practical utility.†

The distinction between Schilling's model and Cooke's earliest instrument is thus stated in Cooke's second volume, (pp. 15 and 17):—

"Within three weeks after the day on which I saw the experiment, I had made, partly at Heidelberg and partly at Frankfort, my first electric telegraph, of the galvanometer form, which is now at Berne. It has been written for and shall be laid before the arbitrators. I used six wires forming three metallic circuits and influencing three needles. I worked out every possible permutation and practical combination of the signals given by the three needles, and I thus obtained an alphabet of twenty-six signals. I had invented the instrument which I called the DETECTOR; by means of which injuries to the wires, whether from water, fracture, or contact, are readily traced; an instrument which, in practice, is never out of my hand, and without which the electric telegraph would be impracticable. But my principal improvement was that my telegraph did not merely send signals from one place to another, but that it was even at that early period a *reciprocal telegraphic system*, by which a mutual communication could be practically and conveniently carried on between two distant places; the requisite connections and disconnections being formed by pressing the fingers upon keys, and the signals being exhibited to the person sending as well as to the person receiving the communication. This improvement was effected by placing a system of keys permanently at each extreme end of the metallic circuit, and by providing each circuit with a cross piece of metal for completing the continuity of the wires when signals were being received from the opposite terminus. The two signal apparatuses being thus thrown into the course of the metallic circuit, every signal was given at both ends concurrently; and the cross piece was made to restore the circuit for a reply on the first communication being completed. This united and reciprocal property is the basis of the electric telegraph, and is inseparable from the practical system. It has been my leading principle throughout, and has impressed itself even upon the forms of my instruments; their distinguishing characteristic from first to last being that my keys and signals have always been joined together into one instrument, and the several instruments into one reciprocal system. In a word, the arbitrators will here recognize the earliest form of the RECIPROCAL COMMUNICATOR, the fundamental condition of the electric telegraph under every varied mode of its operation.

"My earliest apparatus thus comprised, in a complete though improvable form, two essential parts of my system of a practical electric telegraph, viz., the detector and the reciprocal communicator: a third of equal importance is the alarum, without which the electric telegraph would require to be constantly watched, like ordinary telegraphs.

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* Mr. Cooke states to Sir T. Brunel and Professor Daniell, in 1841, arbitrators between himself and Professor Wheatstone—"About the 6th of March, 1836, a circumstance occurred which gave an entirely new bent to my thoughts. Having witnessed an electric telegraphic experiment, exhibited about that day by Professor Muncke, of Heidelberg, who had, I believe, taken his ideas from Gauss, I was so much struck with the wonderful power of electricity, and so strongly impressed with its applicability to the practical transmission of telegraphic intelligence, that from that very day I entirely abandoned my former pursuits, and devoted myself thenceforth with equal ardour, as all who know me can testify, to the practical realization of the electric telegraph, an object which has occupied my undivided energies ever since." *The Electric Telegraph, was it invented by Professor Wheatstone? By W. F. Cooke, in two vols., W. H. Smith and Son, London*, 1856, *vol.* 2, *page* 14.

† Plate 1, parts A and B, Cooke's second volume at the end.

* Messieurs Cooke and Wheatstone's apparatus "was, in the essential part, founded on the same principle as Baron Schilling's, namely, the deflection of needles by multipliers."—*Hamel*, p. 56.

The effect produced by the *practical* Electric Telegraph on an intelligent mind, long accustomed to the Electro-telegraphic Experiments of a lecture-room, is depicted with great *naiveté* by the late Professor Daniell of King's College, in a letter, written, after seeing for the first time, Cooke and Wheatstone's Electric Telegraph in operation between Euston Square and Camden Town; in this letter, Professor Daniell says, he "cannot refrain from expressing," instantly in writing, the pleasure he has felt at "witnessing" the "complete success" of the "Electro-magnetic Telegraph." He is "*quite surprised at and almost at a loss to account for* the different effect produced upon" his "mind by *believing* and *seeing*." Although "he has followed all Mr. Wheatstone's experiments from the beginning, and is intimately acquainted with both the principle and construction of his apparatus," Professor Daniell "has been struck *as with something quite new*." It has produced in him "something of the feeling of magic." He is now satisfied that the telegraph must be "adopted on all railroads immediately," as well as "upon an extensive scale for private communications."

Such was the "magical" difference between "believing and seeing!"—between *believing* in the ideal invention and *seeing* the realization of the *idea* in Cooke and Wheatstone's practical telegraph at Euston Square!"—*Cooke's 1st. vol. pp.* 59 & 158.

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"Before the end of March, 1836, I had invented the alarum, which is still extant in my first mechanical telegraph. It was one of ordinary construction, worked by clockwork mechanism on the removal of a detent. My invention consisted in placing a voltaic magnet in such proximity to an armature of soft iron forming the tail end of a lever detent, that when an electric current passed round the voltaic magnet, the magnetism which was for the moment excited in it attracted the tail end of the lever, and by so doing drew its detent end out of the clockwork; but on the temporary magnetism ceasing with the cessation of the current, the attraction of the tail end of the lever ceased also, and the detent end of it was then replaced in the clockwork by a reacting spring or balance weight."

Dr. Hamel gives the following well-ascertained dates :—*

1809. 8th July (p. 7.)—Soemmering invented his plan for telegraphing by evolution of gas.
1810. 13 August (p. 13.)—Showed it to Baron Schilling at Munich.
1802. May.—Grandominico Romagnosi discovered that the magnetic needle was deflected by galvanic currents, and in August in the same year published the discovery at Trent.—(p. 33.)
1812. "Baron Schilling's operations with a subaqueous galvanic conducting cord, through the river Neva, at St. Petersburgh."—(p. 16.)
1815. 3rd August (p. 34.)—Baron Schelling communicated to Soemmering the "Manuel du Galvanisme," a book printed at Paris in 1805, mentioning Romagnosi's discovery.

Baron Schilling may, therefore, be supposed to have known from this date the fact, that a galvanic current deflected a magnetic needle; although Dr. Hamel come to the conclusion (p. 34), that neither Soemmering or Schilling had any idea of a practical application of Romagnosi's discovery until 1825 or 1826, five years after Ampiere's suggestion.

1820. Oersted directed the attention of the scientific world, more effectually than Romagnosi had done, to the influence of a voltaic current on a magnetic needle. Dr. Hamel supposes him to have been acquainted with Romagnosi's discovery of 1802.—(p. 15.)
1820. Ampere's suggests "that it might be possible to make use of the deviation of the needle for telegraphic purposes."—(p. 24.)
1824. Scweigger invents the multiplier coil.
1830. April.—Is the first clear date given by Dr. Hamel in connexion with Baron Schilling's needle telegraph, when it was shown to the Emperor Nicholas, "who (he adds) had been pleased to notice it in its earlier stage."—(p. 41.) But at p. 66, the Doctor speaks vaguely of "above a dozen years previous" to 1837 as the the date of Schilling's invention.

In 1830, Baron Schilling had known for twenty years the details of Soemmering's telegraph; and, for at least fifteen years, the deflective power of the galvanic current on the magnetic needle.

1835. Schilling shows his telegraph at Bonn, simplified to a single needle and multiplier.—(p. 43.)
1835. Muncke exhibits at Heidelberg a model of Schilling's telegraph.—(p. 43.)
1836. March.—Cooke sees Muncke's model of Schilling's one needle telegraph.—(p. 29.)
1836. March.—Cooke makes two instruments (p. 53) shown in the Drawing, Part B., Vol. II., of Cooke's work, at the end, where they are compared with Muncke's models,
1836. March.—Cooke invents the mechanical telegraph and alarum, in which signals and sounds are given by the removal of the detent of clock-work by the voltaic magnet.—(p. 53.) Also the detector.
1836 April 22nd.—Cooke returns to England to work out his scheme of realizing the old idea of an electric telegraph.—(p. 53.)
1837. January.—Negociates with the Liverpool and Manchester Railway Company for the use of his "so-called mechanical telegraph."—(p. 53.)
1837. May.—The first electro-telegraphic patent applied for by Cooke and Wheatstone for their joint inventions.—(p. 55.)
1837. "Baron Schilling ordered a submarine cable to be made to unite Cronstadt with the capital, through the Gulf† of Finland, for telegraphic correspondence." (?)—(p. 67.)
1837. 25th July.—"A trial was made at the terminus of the London and Birmingham Railway, then constructing, one mile and a quarter in length, from Euston Square to Camden Town. This was the first instance of out-door telegraphing in England with a galvanic apparatus." "Mr. Cooke had been permitted, at the Euston Square terminus, in a large building (the carriage house), to suspend many miles of wire, along which the current was made to pass, besides the wires in the open air, to Camden Town."—(Pp. 55.)

These facts and dates together will, perhaps, indicate to what countries, and in what relative proportions, the realization of the galvano-electric telegraph is really due.

In Cooke's second volume, p. 119, the question of *invention* is thus viewed :—"If the electric telegraph were to be described generally in a few words, how would you describe it? Might it not be called an application of a few known principles, by means of a few simple contrivances, to produce a practical result, which the experiments of scientific men, though their attention had been directed to the subject for a long series of years, had failed to produce?"

Thus Soemmering took up the *idea* of an electric telegraph, and experimented with the decomposition of water by the galvanic current. Schilling, after contemplating these contrivances for fifteen or twenty years, adopts Romagnosi's discovery, and Ampère's suggestion of the practicability of the magnetic needle telegraph; fortifies himself with Scweigger's multiplier of force; and invents a simple and striking instrument, which appears under various modifications in lecture-rooms and scientific journals, for six or seven years, at the end of which it dies out. The very sight of this instrument in operation instantaneously excites another mind to devote itself to the realization of the long barren idea.

To continue the foregoing quotation:—"The merit of the invention must, therefore, consist, in a very great degree at least, in the *practical realization* of that which had before been an idea or an experiment:" and this practical realization belongs to England *—*(Extracted from Mr. Cooke's Comments.)*

* The earlier dates of the Telegraphic idea, by fractional electricity, go back to the middle of the last century; and are accurately traced in an article on the Electric Telegraph in the "North British Review," (January, 1855), to a Scotchman in 1755.

† This is a remarkable statement of Dr. Hamel's, and should be well vouched for, as it would make Baron Schilling the father of submarine telegraphy.

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.—The demand for all descriptions is good. Twenty tons offered at public sale of very ordinary quality. Reboiled, old, partly decayed, and perished, was readily taken by the Home Trade, from 6d. to 11d. per lb.

A few lots of middling genuine, out of the same sale, realized 1s. 4d. per lb. for Export.

Since which, a small parcel of about six tons of fine genuine has been sold by private contract to one of the factories, at 1s. 6¾d. per lb.

India Rubber.—Sales limited, but the holders are very firm.

	s. d.	s. d.
Fine Para	1 9 to	1 10 per lb.
Good „	1 4	1 5
Negro „		0 11
Java and Penang, good quality,		1 3

December 11th, 1861. W. Kirkmann.

Correspondence.

MR. HEARDER'S TELEGRAPH CABLE.

To the Editor of The Electrician.

Sir,—My attention has been rather unexpectedly directed to an article in your issue, November 30th, by one of your correspondents commenting on the Report of the Experimental Committee on my cable. I have had for some time in my possession this voluminous, and I dare say able report, without ever looking into it, for I was so thoroughly disheartened by the delay in its appearance, that seeing no prospect of it at the time of the expiration of the first three years of my patent, determined to take no further trouble about the matter. Now, sir, the fact is, I have not the least idea whether the sample of my cable referred to by your correspondent, and which appears to test so well, has been correctly made upon my plan or not, as it has never been submitted to me for inspection, since I furnished the specification for its manufacture.

From the perfect success of certain samples which I made and tested myself, I was induced to bring my plan under the notice of the Government Committee, and was courteously received by Captain Galton, Professor Wheatstone, and Mr. Latimer Clark. Having explained some of my views, and offered my samples to them, they were pleased to suggest

* *Vide* opinions of Sir Isambard Brunel and Professor Daniell, given in their Award (after p. 73).

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that a two-mile length should be made at the expense of the Government for trial. I felt this to be a high compliment, but finding subsequently some reluctance on the part of the committee to carry out the original suggestion, I consented to a fresh proposition to have a quarter of a mile made, and I was requested to name the manufacturers. Mr. Clarke also intimated to me that I should confine myself to certain definite thicknesses of wire and insulating coating, in order that my cable might be compared with other standard samples of corresponding dimensions, so as to save the trouble of reduction by calculation.

I was also informed that no allowance could be made in the external dimensions for the space occupied by my fibrous material, which must count as insulating medium.

As this fibrous material is a semi-conductor, I thus expected a certain amount of loss of insulation from this diminution in the actual thickness of gutta percha, as I had quite intended to employ the same absolute quantity of gutta percha merely enclosing my fibrous material between its layers, which would have constituted the fairest experiment.

In selecting my relative proportions, I fixed on the smallest quantity of gutta percha possible, in order to put the plan to the severest test, the fibrous material constituting one-fourth of the thickness of the whole dielectric.

The Gutta Percha Company, whom I selected as the manufacturers, were unable to follow my precise plans without constructing fresh machinery, but as that which they proposed to adopt would afford some idea of the merit of the arrangement, I sent them my specification, and requested that I might be furnished with samples in the various stages of manufacture, they having objected to my personal superintendence of the process. I requested also that a length of twenty feet might be reserved for my own private experiment.

I heard no more of this cable until I learnt that it had been finished and handed to the Government Committee. I applied to the Gutta Percha Company for the sample which I had requested them to save for me, but they only handed me the fag end, which unfortunately turned out so defective in construction, that I could not test it. I then applied repeatedly to Mr. Latimer Clark for a sample, that I might be satisfied as to its construction. After writing many months I was favoured with a piece about half an inch long, and in this I find that the wire is not only very much out of the centre, but as a consequence the layers of gutta percha on one side are so extremely thin, that it is only a matter of surprise to me that the cable is insulated at all. I have protested against any deductions being drawn from experiments with it, as I firmly believe that the sample is defective throughout, that is to say the layers and wire are not concentric. Electricians with this explanation will see that I am hardly in a postion to defend my views by reference to experiments with an article which has been made without my superintendence, and by individuals who can hardly be expected to be guided in their manufacture of it by the same theoretical principles which suggested its mode of construction, and which cable, after being constructed, has been tested and reported upon without even being submitted for my approval.

Whilst I feel that I am hardly responsible for any failure in the electrical quality of this sample, I feel extremely mortified that a plan in which I have the utmost confidence should have been brought before the public in so imperfect a manner. With all these disadvantages, however, I thank your correspondent for showing the high position which my cable takes in relation to those made with solid gutta percha, and I will take the liberty of calling attention to a few remarkable points.

I have already stated that Mr. Clark confined me to definite thicknesses of dielectric, making it a condition, that my fibrous material should count as such. The material which I employed was spun out of the very best flax, by a relative of mine, Mr. Yeo, at Stone Park Flax Mills, Plymouth.

The strands are supposed to be passed through an adhesive insulating composition in process of laying on. They lie upon the core in an almost longitudinal direction, and the core thus coated is passed through an equalizing gauge prior to receiving the last coat of gutta percha. In bulk they thus form nearly one-third, say quite one-fourth, of the whole insulating coating, by which I displace an equal quantity of gutta percha. My wire therefore possesses really only three-fourths of the quantity of absolutely insulating material, as compared with another core of equal dimensions, coated with solid gutta percha. It would not then be remarkable if its insulation should suffer a little. I am however pleased to find that it stands so well, especially when I consider how extremely thin the gutta percha is on one side.

If compared with another core containing the same absolute quantity of gutta percha, I know from experiments with samples of my own make, that it will stand much higher.

An important fact, however, is here established, viz., that semi-conducting fibrous materials will not under favourable circumstances interfere with insulation. This, however, was not one of the processes covered by my patent. I might have substituted a non-conducting fibre, which would probably given it a still higher insulating character.

With regard to its capacity for induction, I venture to submit, with all deference, that it is hardly fair to count flax fibre as dielectric, as it certainly forms an intermediate semi-conducting layer between the layers of solid dielectric, and that in comparing my cable with another, it should be with one not one of the same external dimensions, but coated with the same absolute quantity of dielectric, and having my fibrous layer or layers between. When I have so compared samples, I have invariably found the advantage in favour of my own plan.

When, however, we compare the difference between the inductive capacity of a homogenous dielectric with one in which a portion of the dielectric is replaced by semi-conducting fibrous layers, whatever may be the difference in insulating or inductive character, both these qualities are improved by increasing the thickness of the dielectric by that of the fibrous layer, and the following advantage also accrues, viz., that the strength of the fibrous material is added to that of the original core, whilst its insulating and inductive character are also improved; that is to say, of two cables coated with equal quantities of gutta percha, the one containing my intermediate layers of flax strand and tarry compound, and the other the solid gutta percha alone, the former will insulate better, have less inductive capacity, and be enormously stronger.

The strands alone in my government sample will bear a strain of 800 lbs., independently of the wire and gutta percha, and some of my samples of larger size contain from 20 to 50 strands. I contend, therefore, that it is no mean advantage to be able to give to a core an inherent strength of from 1200 to 2000 lbs., and at the same time improve its inductive and insulating character. My layer of flax strand will not cost above one-half as much as an equivalent layer of gutta percha, which constitutes another advantage even in an economical point of view.

Having committed my plan to the care of the Government Committee, I had no means of coming tangibly before the public, until the publication of their report; but as the first three years of my patent expired in the interim, I did not care, from opinions which I had formed as to the probable fate of my plan, to incur any further expense, and it is therefore now public property. I am more than ever satisfied of the efficiency of the plan, and shall be only too happy to assist by my advice any company who may think fit to adopt it.

I send you herewith a description of a new Inductometer, which I have employed in my experiments, and for which the Royal Cornwall Polytechnic Society were pleased last year to award me their first silver medal. Should it be suited to your pages, it is quite at your service.—I remain, sir, your obedient servant, JONATHAN N. HEARDER.

Plymouth, December 7th, 1861.

[WE insert the following communication from an anonymous correspondent, as several of the points referred to may be of peculiar interest to some of our readers.]

To the Editor of THE ELECTRICIAN.

If THE ELECTRICIAN do justice to its opportunity, it can hardly fail of a glorious career; its mission is an enviable one. No science within the whole range of physics is more important, or more needs development than electricity; and it is strange that until now it has never found a periodical representative, *now*, so long after it first became important to the industrial arts; *now*, when it has fairly entered into service as the swift-winged mercury of the world; *now*, that it is becoming reputed as the giant at work at the basis of all our chemical operations. Never has scientific journalism been more tardy in perceiving its occasion, and never before did science offer to it a surer reward; the public will hail the new periodical as destined to supply one of England's intellectual wants—a want that every day must become more common.

But let it be true to its mission. First of all let it teach its readers to preserve inviolate the sanctity of facts, adding nothing to them, detracting nothing from them. To do this is less easy than is imagined; it seldom answers our purpose to merely describe an observed effect; and when we add to the narrative a mental inference, we are apt to delude ourselves with the idea that it is part of the fact itself. Facts are the materials of science, but only so when rightly used, it is possible so to abuse them as to convert them into its bane. Of this THE ELECTRICIAN may, perhaps, hereafter give me opportunity to quote examples, and endeavour to undo some of the ills done by the pernicious practice.

Let it inculcate self-reliance. The discoverers of facts are worthy of honour and imitation; but since all men have not the same gifts, they may be of all persons, perhaps, the least likely to see in facts their useful indications. I say *may be*, not that it is inevitably so, for the opposite is possible, and even probable; but however probable, as no human judgment is exempt from error, so, therefore, no other inference should be permitted to supplant our own, except it be on full conviction, after due reflection. He who pins his faith upon another's sleeve, in matters of scientific inference, without knowing all that is implicated, and approving every step of the argument, may expect to be brought up at the stopping place of his leader, and remain there for ever.

Let it explain to its readers that we have no theory of electricity competent to lead them forward. The one electrical fluid of Franklin requires common matter, as well as itself, to repel its own particles, which is denied by common experience; and Du Faye's Theory of two Electrical Fluids requires electricity to be kept upon the surfaces of bodies by some kind of atmospheric pressure, of which we can form no conception, and in the existence of which we cannot believe. An illustrious philosopher of the present age has tried a new version of the latter theory, by making each of its electricities exert upon matter an influence which matter is supposed to be constrained by its nature to resist; but we no sooner set out with it than we are brought to the difficulty of conceiving how the alleged influence, acting from particles on others contiguous to them, is sometimes

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equally resisted, whether the particles acted upon be few or many. Whereas we are taught by an axiom of universal applicability, that in cases of physical action, cause, and effect, must always be simply proportionate to one another.

Let it encourage its readers to seek for novelties in doctrine, seeing that as the old theories have kept us at a stand-still for about a century, it is quite time to conclude that if we ever progress it will probably be in a direction with which we are unacquainted. I do not mean that they should entertain visionary speculations having no foundation on mechanical principles; but such hypotheses at as first sight recommend themselves to the judgment, and are seen to hold out a promise of becoming clearer and more comprehensive as they are further investigated; among such novelties, perhaps, one may ultimatly be found that will prove to be the very thing of which we are in want. Facts of but yesterday are shining around us; but how can we expect to see their light if we keep our eyes closed to all but our own telescope, never allowing it to deviate from the direction in which it was fruitlessly pointed for us a hundred years ago. We desire to see our theory of electricity, like that of gravitation, yielding all its phenomena as the results of a few simple laws of force; but while we have mingled forces of attraction and repulsion, to deal with simplicity is out of the question, and to infer from observation less complicated views of force necessitates a fundamental novelty in doctrine, and we cannot have it too soon.

Let it suggest to its readers that while facts, and the laws of facts, that is the proportions, or relations, which effects bear to one another, are useful in subserving the exigencies of a civilized community, and administering to the comforts of mankind, both are susceptible of being legitimately applied in another way, and made to aim at a purpose far more exalted; namely, for enabling us, by inductive reasoning, to approach, more or less closely, to that primary physical causation which embodies electricity at the origin of all creation, and is intimately linked, perhaps, by a comprehensible antecedence, to the moral causation with which, as its creatures, we shall never cease to have to do. If we claim to be lovers of knowledge, for its own sake, we must aspire to learn the nature of the electrical forces and the laws which they observe; and if we attain to that knowledge, our further prosecution of the science must be orderly, and our successes incessant, keeping satisfactory pace with our industry; whereas now, in our ignorance of these things, our experimental achievements are fitful, and only obtained in the midst of a harassing mental distraction.

If The Electrician will do these things, it will find willing contributors to its pages; it will promote its own commercial interests; and, what is better than all else, it will prove an instrument for hastening the epoch when a knowledge of physical causation shall confirm the well interpreted declarations of revelation, so that scepticism and philosophy may never afterwatd be found in communion. The journal will then be, not only a record of sayings and doings, but a directory, a guide; and the rising generation, while looking to it for the materials it will require, will find in it also the more valuable instruction—how to use them.

As some excuse for thus proffering counsel to a public character, allow me, Mr. Editor, to plead a zeal, for the science you have undertaken to serve, which has now completed its seventh term of seven years, active amateurship, and still thirsts for knowledge. Au Revoir.

TERRESTRIAL CURRENTS.

To the Editor of The Electrician.

Sir,—Few subjects would have excited more general interest than that of "Earth Currents," or, as I would propose to call them, "Terrestrial Currents."

I propose this name, because, unless I am wrong, there seems to me to be tendency to confuse "*deflections*," as they are called, with feeble battery currents caused by earth plates and other local causes.

It is to these "deflections," or, as I would call them, "terrestrial currents," that Messrs. Preece, Walker, and Varly refer in their evidence before the Submarine Committee.

You have not at present referred to the paper in the *Phil. Trans.* for 1842, part 1, which contains the result of very careful observations made in 1847, and points out the true nature of the phenomenon. It is but fair to the worfs in the "dark ages" of telegraphy to hunt out this paper. It is so old that but few are aware of its existence.—I am, sir, yours, An Old Hand.

New Marine Glue.—This composition, patented by Mr. W. J. Hay, of Portsmouth Dockyard, is much cheaper than marine glue, and will, therefore, be used largely by the shipping interest generally. In addition to the purposes to which ordinary marine glue is applicable, the waterproof glue from its extreme low price, may be used for caulking and paying the seams and decks of all classes of vessels, and will, consequently, become a substitute for the costly marine glue and the inexpensive pitch. This glue, which has been tested by seven years' trial, has been found the cheapest and most durable application for iron, wood, and all other kinds of roofing and fencing, also a good substitute for bottling wax and metallic capsules, and a desirable covering for posts, piles, &c. The following are the best proportions for this ingredient:—Trinidad pitch, or asphalte, 60 lbs.; vegetable tar, 15 lbs.; oil naptha, 2 lbs. Instead of oil of naptha, 2½ lbs. rough creosote, or 4 lbs. of oil of turpentine may be used. Does it insulate?

To Correspondents.

"One who wishes to Know."—We are certainly not answerable for the selection of the committee. If you will refer to the Report you will find that four gentlemen were appointed on behalf of Her Majesty's Government, and the remainder on behalf of the Atlantic Telegraph Company. Professor Wheatstone was on the Government Committee, so was Captain Galton, G. P. Biddre. Esq., and Dr. Fairbarn; on the other side you had Messrs. Edwin, Latimer Clark, Varley, and Saward. The Report, as you will perceive, is a "Joint Report." The Malta and Alexandria cable was designed by other parties, and previously, we believe, to the appointment of the joint committee. The recommendations of the committee have not yet, as far as we are aware of, been carried into effect. The 200 miles of cable to be sent out to the Red Sea, or rather to the Persian Gulf, are to be supplied by the Gutta Percha Company. You would not, surely, recommend a *new material* to be used for the purpose of simply repairing a precarious *old one*. Should the *old* fail, the failure might be attributed to the *new*. The "extensive experiments" you allude to, with a view of overturning the tests of the Government Experimental Committee, are "out of date;" they may afford pleasure and gratification to those interested, but we very much doubt that they will increase the knowledge we already possess; at all events, we hope that no capricious objection to this or that material will have any prejudicial effect upon public enterprise. Confidence is being gradually restored in submarine telegraphy, and, as far as we are concerned, we shall endeavour to increase and strengthen that confidence to the utmost of our ability. The improvements you suggest have, we believe, been anticipated by another party; this does not, however, lessen their value.

"Anxious."—See reply to "One who wishes to Know." Deep sea telegraphy must succeed. The gentlemen employed upon the Malta and Alexandria cable were, we believe, selected from the staff of the old Atlantic Telegraph Company. The cable is represented as in good working order; but, unfortunately, there is a mystery about many submerged cables which it is difficult to fathom—they are beyond our depth.

F. H. S., Cuckfield.—1. See the paper of Mr. Clark and Sir C. Bright in No. 1 of The Electrician. The *volt* only would require the prefix milli. A millivolt means properly the thousandth part of a volt; but the term has been applied to the millionth part of a volt. We shall probably have shortly to describe a new system of measurement founded on that proposed by the above-mentioned electrical engineers. 2. The resistance of a wire, and its degree of conductivity are opposite, but equivalent terms; the question is fully explained in "The Student" in the present number. 3. A table giving the diameters of copper wires will be inserted as soon as possible. 4th. The Peltier Electrometer is the best form of the instrument; it readily indicates the increase of atmospheric tension which precedes a flash of lightning. In induction observations it may be placed on a stand in the open air; in this case it may be wholly enclosed in a glass shade. The brass-work should be brought into contact with a wire attached to a plate of copper upon the stand; this plate being connected to earth. The instrument is placed so that the magnetized needle may be as nearly as possible in the magnetic meridian; the indicating needle being in contact with the cross arms. A compass is sometimes employed to indicate the meridian. The instrument shows the decrease as well as the increase of atmospheric tension; if properly insulated it seldom remains long at zero.

A. H. B.—Highton's History of Telegraphy, and Walker's Telegraph Manipulation, are very useful works, the latter is to be had of Messrs. Knight and Co., Foster Lane. The current from the three Smee's cells should possess at least four times the quantity of the current from the six small Daniell's. The Smee's battery is a very powerful arrangement; but is liable to great objection in practice, and is, therefore, seldom employed.

R. E. S., Northampton. The trough battery you describe would be far more difficult in construction than the Daniell's cells. The trough itself would necessitate a considerable degree of skill in carpentering on the part of the student making his own battery. The partitions formed by the porous plates would require to be watertight, or nearly so. The connecting strip would, we suppose, require to be soldered to the zinc and copper elements—an operation involving some trouble. What would be the *cost* of constructing a hundred couples on this plan? Something more, we presume, than the cost of one hundred cells of the students' battery.

Viator.—We cannot ascertain the amount of battery employed by Mr. Crosse in his experiment with fluo-silicic acid. With silicate of potassa, the battery was six small Daniell's cells; and it appears probable that the same battery was employed in the case you mention. In the other instance, the voltaic arrangement was of small quantity and considerable tension, viz., nineteen pairs of fire-inch zinc and copper plates excited by water only. The battery should be sufficient to effect the slow decomposition of the medium employed. We shall be anxious to hear of the result of your proposed experiment.

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The Electrician.

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THE PRINCE CONSORT.

The sudden and premature death of an illustrious prince, long deservedly recognized as the most distinguished and enlightened patron of science, is an event which has peculiarly awakened the deepest sorrow and grief amongst all those who follow its intricate paths; and with heartfelt sincerity do we unite with our fellow men in offering our deepest sympathy for the severe and sad loss which our beloved Sovereign, and her youthful family, have experienced.

A valuable life, in its prime of manhood, full of vigour and activity, tenderly devoted to the highest obligations of its being, and ever watchful over the welfare of its adopted people, has passed away from amongst us, but long shall the memory of its exalted virtues remain enshrined in the affections of a grateful nation.

His Royal Highness, during a period of twenty-two years amongst us, unswervingly followed the path which ever leads to true honour and happiness. Amiable, highly accomplished, and a friend to progress, his aid and assistance were at all times readily and cheerfully granted for the promotion of useful and beneficial undertakings.

A distinguished writer, in an interesting memoir of the deceased Prince, after referring to his studies of our system of law and jurisprudence, and our constitutional history, proceeds:—

"He also devoted his attention to practical agriculture, with which object in view he commenced a variety of scientific experiments on his model farm in the great park at Windsor, and became a constant and far from unsuccessful exhibitor at the annual cattle show, formerly in Smithfield, and more recently in Baker Street, as well as at the provincial meetings of the Royal Agricultural Society. The effect of his example and encouragement upon the progress of agriculture can scarcely be overrated.

"Though the Prince studied political science and the British constitution in theory, he was always wise enough to keep aloof from party politics, and never to interfere in the ordinary course of the administration of our Government, though always ready, as a husband and as a friend, to advise and assist Her Majesty in such matters as did not happen to be beyond his proper sphere. He judged most correctly and most happily that, taking into account his position as the Consort of Royalty, his more fitting *rôle* was to show himself the active and zealous promoter of all those social and sanitary movements which have for their object the moral elevation of the masses; and nothing gave him greater pleasure than to be called upon to lay the first stone, or to inaugurate the opening of such institutions as baths and wash-houses for the poor in crowded neighbourhoods, industrial and ragged schools, and those more ambitious schools of art and design for the middle classes which have sprung up into active existence during the last ten years with such marvellous rapidity, and have been crowned with so much success. We are not guilty of the least exaggeration when we say that to the late Prince's fostering care and energy the nation at large owes not a little of the vast improvement which of late years has characterised most objects of ordinary manufacture, in point both of shape and form; and it is quite certain that the Great Exhibition of 1851 would never have attained the complete success which so eminently distinguished it, had not Prince Albert taken the matter in hand when it was still in embryo, and, discerning in it the elements of an institution of national and even of world-wide utility, helped it forward by a combination of energy, tact, patience, and perseverance, which, to say the least, are more frequently found among our merchant princes than among the well-endowed and highly-favoured circles of Royalty. In the same spirit the Prince watched over the commencement and gradual progress of the new national museums at South Kensington, which have had such an extended influence upon the general study of art and design, and of the circle of physical sciences. Nor were other institutions of a more prosaic character, as being exclusively philanthropic in their scope and aim, forgotten by the illustrious Prince who has been thus suddenly removed from among us; and historians will hereafter record with satisfaction that the same Prince who inaugurated the Crystal Palace in Hyde Park felt a pleasure in accompanying his illustrious son, the heir to the British throne, to the opening of a free school for the instruction of the children of poor costermongers, in more than one of the lowest neighbourhoods of this metropolis."

The discoveries in electricity and magnetism, and the more accurate knowledge we now have of light, heat, storms, and meteorology in general, as well as other great natural phenomena have all had an earnest promoter and intelligent interpreter in Prince Albert, and owe much to his countenance and patronage; and we may here notice an interesting fact that His Royal Highness, in his youth, passed a few years at the University of Bonn, where he had an opportunity of becoming thus early acquainted with that wonderful invention, the electric telegraph, which at the time engaged the attention of the philosophers at that and other universities in Germany, and to those early engaged in promoting the practical introduction of the invention into England, the interest which His Royal Highness evinced in its success cannot be otherwise than gratefully remembered. The telegraph found its way at an early date to most, if not all, the Royal residences; and recently, when Her Majesty's Government invited the advice and assistance of men of science and others, as to the best method of extending the system of ocean telegraphy, His Royal Highness, as in all other matters having for their object the amelioration of society, evinced the deepest interest in the progress of the committee's investigations.

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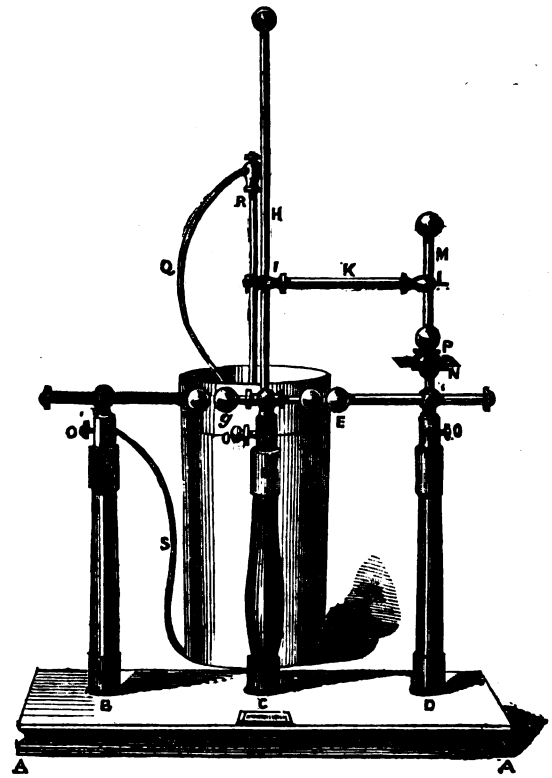
THE ATLANTIC TELEGRAPH.

The extensive warlike preparations, involving an enormous expenditure, which are being made in anticipation of an unfavourable reply to the demands of the British Government upon that of America, naturally gives rise to the important question, how far an Atlantic telegraph, by affording an instantaneous means of communication, would have relieved the nation of this enormous expenditure, and the painful suspense and anxiety which must exist for the next ten or twelve days? The expense already incurred would have been more than sufficient to construct a submarine line between the respective shores; and during the next few days will probably exceed the expense of two or three such lines, while the cause of so much anxiety and expenditure may perhaps ultimately be honourably and amicably settled. Should a war prove inevitable, the speedy means of communication between England and Canada would have conferred incalculable advantages upon this country. The practicability of deep sea telegraphy being fully recognized by all our leading engineers and electricians, so desirable an undertaking might be easily and expeditiously carried out. A cable of a slight specific gravity, and of the requisite strength, could be furnished by some half a dozen of our cable manufactures in a few months time, and the Great Eastern, with her ample accommodation, might be employed for laying it down. During the Crimean war the cable between Varna and Balaklava rendered the most valuable services, and according to a statement made by Lord Lyons "lessened the duration of the war by two or three months." It is to be hoped that Her Majesty's Government will, should war be declared, avail itself of the services which an Atlantic telegraph would be capable of rendering in cases of great emergency, such as are likely to happen when two powerful nations are at war. Precautions would be taken to protect the line where submerged in shallow water. The depth of the Atlantic affords a sufficient security against attempts on the part of the enemy to destroy it in the open sea.

INSULATION.

Numerous articles and letters from correspondents have appeared in our columns upon the important subject of insulation, and the various materials employed for that purpose, in both aërial, subterranean, and submarine telegraphy. The matter having been so recently investigated by a committee appointed by Her Majesty's Government, we will endeavour simply to place before those of our readers who may not have the advantage of the practical knowledge of the working of a line of telegraph. In our "Student," the battery and the mode of its manipulation have been fully described. Insulation commences first with the battery itself, in order to secure the full power created by the chemical action between the positive and negative element, it is essential that the battery should be insulated so as to prevent the galvanic power, thus developed, escaping into the earth. The wire employed to connect the battery elements, whether a foot, or one thousand miles in length, should also be insulated, or kept from contact with earth, by means of a substance which does not allow a passage to the electric agency. For this purpose, in aërial telegraph lines various materials are employed, such as earthenware, glass, porcelain, ebonite, &c., and the better the line is insulated, the more economical and certain its operations. Great improvements have lately been made in the materials so employed, and with corresponding advantages. When the wire which connects the poles, as above described, passes through earth or water, it becomes necessary in that case to completely encase or envelope it in an insulating material, to prevent the passage of the current into the earth; for this purpose various materials have been employed, but of late, exclusively gutta percha, which, when in a pure state, is an excellent insulator.

Recently we have had several other materials and compounds introduced for insulating purposes, such as india rubber, Chatterton and Wray's compound, and Godefroy's, which are highly spoken of in the Report of the Committee above alluded to. The object of providing a superior insulator in the case of the subterranean and submarine conductor is, as in that of the aërial line to secure for actual service the full power generated by the battery, without loss by leakage. The retardation, or what is sometimes called absorption, at other times induction, is less upon a superior insulated wire, than it is upon a wire covered with an inferior insulator.



THE INDUCTOMETER.

BY J. N. HEARDER.

A new instrument for determining the specific inductive capacity and insulating power of dielectrics, by frictional electricity.

The enormous outlay involved in the construction of a submarine telegraph cable, and the ruinous consequences of its failure, render the practical determination of the problem—what is the substance best suited for insulation?—a matter of the deepest importance.

Hitherto gutta percha has been generally considered as the most eligible substance for this purpose, probably on account of the facility with which wires can be coated with it. The frequent failures, however, which have occurred in cables after they have been laid, in consequence of the insulation becoming defective, and the great difficulties experienced in working through very long lines, from the disturbing influence of the inductive action, have induced electricians to turn their attention towards the discovery of a substance which should be free from these defects. Within the last few years some most important experiments have been made with india rubber as an insulating medium, and with very great success. Valuable papers on the subject have been laid before the British Association by Messrs. Hall and Wells, and by Mr. Silver, and the scientific journals of the day teem with discussions on the respective merits of the two rival substances—gutta percha and india rubber.

Although perfect insulation is of paramount importance, yet there are other qualities which an insulator should possess in addition to its electrical impermeability, and of these, the most important is low inductive capacity—that is to say, small capacity for receiving static charge. The conditions of the Leyden jar, which are fulfilled in a submerged coated wire—the wire forming the inner, and the sea the

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outer coating—give rise to electrical accumulations or charges on the inner surface, which produce great disturbances by their discharge, after the battery current has passed through.

The amount of this charge taken up, varies not only with the thickness of the insulating coat, but with the character of the insulating material itself, since different insulating substances have different inductive capacities or capabilities of taking up charge.

The mode usually practised by telegraph engineers and adopted by the Government committee for the determination of the specific inductive capacities of cable coatings, and the modifications produced by varying the thickness of the dielectric, has been to immerse a certain length, varying from a quarter of a mile to five miles of telegraph cable or insulated core, as it is termed, in water, with the exception of the two ends, which are kept out of water and carefully insulated. This arrangement forms a Leyden jar or tube. From one pole of a battery of considerable intensity (500 pairs of plates), the other pole of which is in contact with the earth, a charge is thrown into the cable by bringing it in contact with one of the ends projecting from the water. The amount of this charge is measured by causing the electricity to pass through a galvanometer in its way to the cable, which thus indicates by its deflection the force of the wave which has passed through it. This process serves also to discover the integrity of the insulation, for, should any defect exist, it will be shown by a permanent deflection of the galvanometer as long as the pole of the battery is in contact with it, and the extent of the defect may be estimated by the amount of deviation. After the first charge has been communicated and noted, the pole of the battery is suddenly removed, and the terminal of the galvanometer with which it was in contact is quickly put to earth, so that the charge taken up by the cable may flow back through it and discharge itself to the earth. This causes a deflection in the opposite direction, the degree of which is assumed to indicate the amount of the charge retained by the cable.

As this effect is identical with that which takes place in the actual working of a telegraphic line, it is almost the only test used by electricians. Since, however, it can only be depended upon when instruments of extreme accuracy and a considerable length of cable are employed, the experiment is often an expensive one. I have therefore thought it desirable to contrive an instrument by which the specific inductive capacities of dielectrics and the effects due to variations in their thickness might be examined by using very small samples either before or after manufacture, and I have had the satisfaction to succeed very perfectly.

For this purpose I have employed frictional electricity, and the rationale of the process which I adopt is as follows:—

All good insulating substances are capable of being charged when laminated and placed between metallic coatings, after the manner of a Leyden jar or plate. The amount of charge which equal coated surfaces will take up—the tensions being equal—will be directly as their specific inductive capacity, and inversely as their thickness. To determine this, I take a Leyden jar holding about a square foot of surface, which I employ as a standard, and placing it on the table, I connect with the inner coating a Lane's discharging electrometer, adjusted so as to discharge the jar when the tension is sufficient to overleap the interval of one-tenth or two-tenths of an inch. Now, if I charge this jar by a number of small units of quantity, the value of each unit will be determined by the number required to produce the discharge; and if in one case I find a hundred units necessary, and in another case only fifty, I take it for granted that the value of these units is as one to two, the fewer number having the greater value.

I next take a number of dielectrics, all in plates of the same size and thickness, and having equal areas of their central portions, coated on each side with tinfoil or any metallic conductor. If one of these coated dielectrics be connected with a discharging electrometer, adjusted to a very minute discharging interval, say one-twentieth or one-fiftieth of an inch, it will discharge whenever the tension has reached this point; but the quantity of electricity contained in that discharge will vary according to the nature or thickness of the dielectric. Let, now, one of these coated plates be insulated, and have one of its coatings connected with the conductor of an electrical machine, and the other with the inner coating of the standard jar, so that the discharge through the electrometer connected with the coated plate under examination shall not pass to the ground, but into the jar serving to charge it. Let the number of discharges from the coated plate required to cause the jar to discharge through its own electrometer be noted. These may represent the inductive capacity of the dielectric. Let now a different dielectric be substituted for the first, all other things—the discharging intervals, &c.—remaining the same, and let the number of discharges requisite to charge and discharge the jar be noted as before.

The specific inductive capacities of the two dielectrics under examination will be inversely to each other, as the numbers of their respective discharges, since the value of each unit of discharge must be greatest in the one giving the fewest. In like manner, the law regulating the inductive capacities of various thicknesses of the same dielectric may be ascertained by coating equal areas of such plates, and estimating the value of their respective units of discharge.

As, however, the employment of two discharging instruments for this purpose was frequently inconvenient, I contrived the instrument which I have the honour to submit for the consideration of the judges of the Royal Cornwall Polytechnic Society, and to which I have given the name of Inductometer.

It is in principle a double discharging electrometer, and is so arranged that the dielectrics under examination, together with the standard jar, are all connected with, and perform their various functions in different parts of the same instrument.

It consists of a flat mahogany base AA, upon which are fastened in a line with each other and about three inches apart, three strong glass pillars about eight inches high, B, C, D; the two end ones are surmounted, each with a horizontal sliding wire terminated by a brass knob E e, and graduated to tenths of an inch. These wires slide in the same longitudinal line, and their brass knobs point towards the centre pillar C. This pillar is surmounted by a brass cap, F, from opposite sides of which project two brass wires, terminated by balls, G g, so contrived as to be capable of being brought exactly in contact with the knobs, E e, of the before-mentioned sliding wires when they stand at zero. Thus adjusted, all the wires and knobs stand in one and the same line. By means of micrometer screws, the balls, E e, connected with the sliding wires on the end pillars can be withdrawn to any required distance from the corresponding knobs, G g, on the centre pillar, thus forming two discharging intervals. From the centre pillar rises a stout upright wire, H, carrying a slider, I, from which projects horizontally, a brass wire, K, terminated by a ball, L, through which also slides vertically a brass wire, M, about four inches long, carrying a knob at each end. The horizontal wire is of such a length as to allow this last-mentioned vertical sliding wire to stand exactly over the centre of one of the end glass pillars, D, upon which is screwed horizontally a flat brass disc, N, of about two inches diameter. The cap of each brass pillar is furnished with a binding screw, O O O, for making the requisite connections.

To use the instrument, the end glass pillar surmounted by the flat brass disc, is connected with the prime conductor of an electrical machine, which conductor should be very small, the smaller the better. Upon the brass disc, N, is laid a plate about three inches square of the dielectric to be tested, and upon this a second brass disc, P, of similar diameter, but of five or six ounces in weight, is placed exactly over the lower one, the knob of the sliding wire, M, connected with the centre pillar, rests upon the last mentioned disc. These two brass discs serve as metallic coatings to the dielectric to be tested. A wire, Q, from the cap of the centre pillar, C, proceeds to the knob of the standard Leyden jar, R, and a wire from the cap of the third pillar, B, to its outer coating. Great care must be taken to varnish all the glass surfaces, and to keep them perfectly dry, as a very small amount of leakage from moisture will produce great errors in the results. Matters being thus arranged, and the discharging knobs between the pillars set at a distance of 1-20th or 1-50th of an inch from each other, if the machine be turned, the under surface of the dielectric to be tested will go on charging until the tension is sufficient to discharge to the proximate knob of the centre pillar, which is in conducting communication with its upper surface. The quantity thus transmitted passes to the inner coating of the Leyden jar, and may be considered the first unit.

The dielectric now receives a second charge, which in a like manner discharges, and is conveyed to the Leyden jar, constituting the second unit or measure. In this way successive discharges pass and are measured into the Leyden jar until it has itself received sufficient to discharge between the centre pillar and the proximate knob in conducting communication with its outer coating. As this discharge passes to the ground, the whole system is rendered neutral, and the experiment is concluded. Since the same quantity in the Leyden jar will always discharge over the same interval, it follows that the number of units or measures thrown into it from the dielectric will be the fractional parts of the charge of the jar, and the specific inductive capacity of the dielectric may be represented by this fraction.

If the dielectric be removed, and a similar plate of another kind of dielectric inserted in its place, all other things remaining the same, the number of units now required to discharge the Leyden jar will give the fraction, which will represent its inductive capacity. If, however, these numbers be compared with each other as whole num-

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bers, then the inductive capacities of the substances compared will be in the inverse ratio of them.*

Another mode of using the instrument is to substitute in the place of the dielectrics to be tested, an extremely small coated plate of glass or other dielectric, which is itself to act as a standard unit of measure. The discharges between this and the centre pillar will always be of the same value. The dielectrics to be tested must now be inserted in the place of the Leyden jar, one coating being in connection with the centre pillar and the other with a third pillar, which, again must connect with the ground. The number of discharges now required to make each dielectric discharge over a given interval, will indicate the exact ratio of their specific inductive capacities.

This instrument affords a ready means of determining not only the law of radial induction through cylindrical dielectrics, but the relative merits of various modes of insulating telegraph cables, and this, too, with only a few inches in length of each sample. For this purpose the circular disc, N, on the first pillar is removed, and a small brass cup inserted in its place. The vertical wire M, with its sliding tube L, is removed from the end of the horizontal arm K, and a brass ring, about one inch in diameter, is screwed on in its place.

The pieces of telegraph cable to be tested are cut into lengths of about twelve inches. The insulating coating is removed from one end, so as to leave about half an inch of the internal wire bare. The other end of the cable is covered with a resinous cement, to conceal the end of the wire. Each sample is then coated externally with tinfoil to within an inch of each end, taking care that all the coatings of tinfoil shall be of the same length. Leyden tubes or jars are thus formed, which are to take the place of the dielectrics before described. It is merely necessary to support them vertically by passing them through the ring against which the tinfoil coating should rest, whilst the wire protruding from the lower end stands in the brass cup placed for that purpose. Small as these samples are, they receive very definite amounts of charge—so definite, indeed, that the number requisite to produce the consecutive discharges of the standard jar will sometimes vary more than two or three per cent. in a dozen experiments. The effects due to the various relations of the diameters of the dielectrics and their included conducting wires to each other, are shown by this instrument with extraordinary accuracy, and the laws regulating these results are readily determinable.

As different dielectrics possess very different degrees of impermeability to the electricity, variations in these qualities may be also ascertained by this instrument. In this case it is only necessary to place the dielectrics between the charging discs, as before described, and connect the cap of the centre pillar with the table, instead of the Leyden jar, which is now dispensed with. The discharging interval between the knobs E G is to be gradually increased until the distance is so great that the electricity prefers breaking through the dielectric between the discharging discs. The relative degrees of impermeability will thus be indicated by the amount of tension which they will bear before breaking down. Of course this will only hold good with certain classes of dielectrics, for the resistance of glass is so great that it would be extremely difficult to accumulate upon it a tension enough to break through it. The softer materials, however, easily yield, and give very good results.

* In all these experiments, however, it must be borne in mind, that a certain effect is also due to the quantity transmitted by the conductor, which gives up its share at every discharge of the dielectric. It is, therefore, necessary, first, to ascertain the fractional value of the conductor alone, by carefully counting the number of sparks which will pass the discharging interval in order to charge and discharge the standard jar. This fraction being ascertained it will always form a constant quantity to be deducted from the apparent fractional value of the dielectric.

INTERESTING FACTS ABOUT ELECTRO-PLATING.

The art of electro-plating sprung from a discovery made at the same time, about twenty-five years ago, by Mr. Spencer, of England, and Professor Jacobi, of Russia. They noticed that when a galvanic current was passed through a solution of copper, it deposited pure metal upon a conducting surface, and from this they advanced to the copying of medals and other objects by electricity. Being unable to agree about taking out a joint patent, the discovery was published and given to the world. When first announced, persons of all grades and sexes became electrified with it, and amateur electrotypers, with their moulds and batteries, were to be found in almost every household. From an amusement, the discovery has grown up to be a grand and beautiful art. It essentially consists in coating articles, such as table-spoons, cups, and various vessels, made of brass, copper, or white metal, with a skin of pure silver or gold, by a current of electricity passed through the solution in which the articles to be plated are immersed. The electric current which is most commonly employed in electro-plating is derived from the decomposition of zinc plates, in what is called a "Smee battery," which consists of alternate large plates of zinc, and a negative element, such as copper or a platinised plate. A constant quantity current of electricity derived from a magneto-electric machine is equally applicable, and is now practically employed for this purpose. We will describe the art of electro-plating in such a manner that it may be very generally understood.

Let us suppose that at one side of a room there stands a long and deep wooden box, with two horizontal copper rods on its top, placed near together, and extending from end to end. The wire from the positive pole of the battery is attached to one of these rods, and the conducting wire of the negative pole to the other. The trough is nearly filled with a straw-coloured solution, made by dissolving silver in aquafortis (nitric acid), and obtaining nitrate of silver in crystals, then forming another salt, the cyanide of silver, by combining the silver of the nitrate with the cyanide of potassium.

Let us also suppose we have an old or a new teapot to be plated with silver. After its surface has been perfectly freed from grease and oxide, it is ready to be put in the solution by a copper wire suspended from the copper rod connected with the negative wire, and just opposite to it: there is also suspended in the box a sheet of silver connected with the other copper rod that is in communication with the positive wire of the battery. An electric circuit is now formed, and a current passes down through the sheet silver, dissolving it, thence it passes through the solution to the teapot or article to be plated, and deposits a coat of silver over its surface, by decomposing the solution, and making it adhere to the negative pole. When a coat of sufficient thickness is deposited, the article is lifted out, washed in soft water, and its surface polished with a steel burnisher, when it becomes as bright as the face of a mirror. This is a description of the art of electro-plating, and it may be practised for pleasure by almost any person having a small machine or battery, and a very inexpensive apparatus.

The wire which proceeds from the copper plate of a galvanic battery to a depositing trough is called the *anode*, the positive pole; that which proceeds from the zinc plate to the trough is called the *cathode*, or negative pole. The plate of silver to supply the solution is connected to the anode. The current passes from the positive to the negative pole, carrying the silver with it, and making it adhere to the prepared metal. In reading scientific works on electric science, many persons become confused with the use of the terms positive and negative. The zinc plate is the positive element, the copper the negative; but as the current passes from the copper along the wire, the pole of the copper is the anode. The electricity passes to the zinc, thence it traverses to the copper through the solution, forming the mysterious electric circuit.

Not many years ago silver-plated wares were all manufactured by placing leaf silver upon the surface of copper and brass articles, then submitting them to the action of fire, by which the silver was partially fused and thus made to adhere. This was called "fire-plating," an art still pursued to a considerable extent in England and France. But electro-plating, though so recently discovered, is much more generally practised. Much of the hard wares, such as communion service plate and tea-table sets, which are exposed in jewellers' show-windows, are indebted to the electric current for their beauty and brilliancy.—*Scientific American.*

MAGNETIC ELECTRICITY.

The fundamental facts of magnetic electricity are few and simple. If a permanent steel magnet is brought near a piece of iron, the iron is converted into a magnet, and on the withdrawal of the steel magnet the iron loses its magnetism. If the iron is wound spirally with a piece of insulated wire, as the magnet is brought near the iron of the spiral or helix, a wave of electricity goes through the helical wire. This wave is momentary, the current instantly ceasing, and no further manifestation of electricity is made as long as the iron core remains magnetic. But on the withdrawal of the permanent magnet, and the consequent destruction of magnetism in the iron core, another wave of electricity passes through the helical wire in the opposite direction to the first. When the north pole of the magnet is brought near the iron core of the helix, the current is in one direction; and when the south pole is approached, the current is in the opposite direction. Thus the current induced by the approach of the south pole is in the same direction as that caused by the withdrawal of the north pole.

Magneto-electric machines are made with a magnet to revolve as close as possible to the end of an iron core of a helix, and each revolution produces four waves of electricity through the helical wire, two on the approach and withdrawal of each pole.

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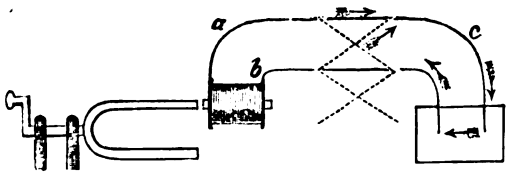
One half of the time the electricity is going out of the end *a*, of the helical wire, and the other half out of the end *b*.



In electro-plating, the metal is deposited upon the plate through which the current leaves the bath. Hence, in electro-plating with a magneto-electric machine one half of the current would be lost unless its direction could be changed at each passage of the magnet past the end of the core of the helix. This is easily done by bringing the wire *c* alternately in contact with the wires *a* and *b*, the contact being made with each wire at the time the current is passing out through it. Many mechanical devices have been employed for changing the direction of the current, and they have received the technical name of pole changers. One of the simplest is represented in the cut. It consists of one pair of parallel wires to be introduced to complete the circuit while the current is passing out through *a*, and a pair of cross wires to be introduced to complete the circuit while the current is passing out through *b*. A glance at the cut will show that this causes the current to pass constantly in the same direction through the bath, though its direction through the wires *a* and *b* is frequently being reversed. Any simple mechanism may be employed to introduce alternately the pair of cross wires and the pair of parallel wires.

Electricity, like heat, varies in intensity. A hogshead full of boiling water contains a large quantity of heat, though the heat is not very intense; on the other hand the jet of a compound blow-pipe is intensely hot, though the quantity of heat is small. Electricity varies in the same way in its relative quantity and intensity. In magneto-electrical machines, in which a number of helices are employed, it is found that the intensity of the electricity is increased by connecting the wire of one helix with that of another, in a way to pass the current through several helices in succession, while the quantity is increased by bringing the several wires together in one bundle, and uniting thus the currents of all.

These fundamental facts will enable any one who has not made a study of magneto-electricity to understand the beautiful electro-magnetic machine.—*Scientific American.*

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 65.]

We submitted wires covered with gutta percha, india rubber, and Wray's compound, 110 yards in length, to pressure of 3 tons to the square inch for periods of a month. The wires were placed in iron pipes connected with an hydraulic press, by means of which the pressure was continually maintained. We had intended to obtain higher pressure, but we experienced so many failures in the attempt that we were at last obliged to give up the endeavour. An examination of the tables will show that, except where specific faults occur, either from joints or from the pressure of the wire against the connexions in the pipes, the condition of the wire after the pressure was put on remained strictly uniform, the loss of insulation following very closely the temperature of the water in which the specimen wire was immersed.

The general conclusion at which we have arrived, from a careful consideration of these and other experiments, is, that the absorption of water by these substances is not to be feared as a cause of deterioration; and that pressure improves the insulation, whilst it is being applied, its effect being more obvious as the material is a worse insulator; and there appears to be less difference in india rubber when subjected and not subjected to pressure than in any other of the materials experimented on.

When the first submarine telegraphs were laid, the size of the conducting wire or the thickness of the insulating material had not become prominent matters of inquiry. Some retardation of the electric currents in underground work had been observed; but in the first short submarine lines but little practical inconvenience resulted, and it was not until lines of considerable length had been laid down, that the subject of induction excited much attention.

It was early seen that the inductive action must be in some ratio proportionate to the thickness of the insulating medium, but the actual value of this ratio was unknown; the thickness of the gutta percha was accordingly increased with the feeling that some increase was necessary, but no real grounds existed for determining what that increase should be, nor were any clear notions entertained of the precise action of induction in causing the retardation observed. In 1854 Mr. L. Clark brought under the notice of Professor Faraday certain experimental results he had obtained in telegraph lines between London and Manchester, and Professor Faraday explained before the Royal Institution the general principles which govern these effects.

When a metallic wire is enveloped by a coating of some insulating substance, as gutta percha or india rubber, and is then surrounded by water or damp earth, the system becomes exactly analogous to a Leyden jar or coated pane; the insulating covering represents the glass, the copper wire the inner metallic coating, and the water or moist earth the external coating. The electricity with which the wire is charged, by bringing the pole of an active battery in contact with it, acts by induction on the opposite electricity of the surrounding medium, which in its turn reacts on the electricity of the wire, drawing more from the source, and a considerable accumulation is thereby occasioned, which is greater in proportion to the thinness of the insulating covering.

One mile of copper wire, one-sixteenth of an inch in diameter, presents a surface of 85·95 square feet, and the inductive circumstances being assumed to be the same, receives the same charge from a source of the same tension as a Leyden jar having an equal capacity. There is, however, one material difference between the two cases. Though both are discharged in a time inappreciably minute to the senses, the discharge from the wire occupies a comparatively much longer interval than that from the coatings of the jar. A wire on insulating supports, in the open air, when it is unconnected with the earth, receives also a charge, but very much smaller in amount, the inductive action of distant surrounding bodies exerting but little influence upon it.

Although certain general conditions of this inductive action in telegraphic wires had been made the subject of experiment, and were well known, when we commenced our inquiry the knowledge of the subject still remained limited. It was therefore thought desirable that a series of experiments should be instituted, under circumstances as closely resembling those which take place in actual telegraphic lines as possible, in order to determine the amount of inductive discharge in wires of very considerable lengths, according to variations in the lengths of the wires, their diameters, the material and thickness of the insulating substance, and in the temperature and pressure of the medium by which they are surrounded.

The results of these experiments may be briefly summed up as follows:—

1. The amount of discharge of a battery is proportionate to the electro-motive force or tension of the battery.

2. The discharge is directly as the length of the wire.

3. When a discharge is effected simultaneously from a number of wires united at their discharging ends, the effect on a galvanometer is the same as when the wires are all united together to form one continuous length.

4. The conductivity of the metal, other circumstances being the same, does not influence the amount of discharge. Hence by employing a bad conductor the resistance of the circuit is increased, the induction remaining the same.

5. The theoretical formula given by Professor Thompson in his evidence for the electro-static capacity of an insulated wire is as follows, viz.:—If D denotes the diameter of a copper wire of circular section, symmetrically covered with insulating material to a diameter D', and I denotes the specific inductive capacity of the insulator, and log. denotes the Napierian logarithm of the number to which it is prefixed, the expression for the electro-static capacity of an unit length of conductor thus insulated, when the outside of the insulator is kept in communication with the earth, is $\frac{I}{2 \log. \frac{D'}{D}}$, and this is assumud by many experienced experimentalists correctly to represent the phenomena. It appears from the experiments above mentioned that the amount of discharge from wires of different diameters with coverings of various thicknesses of the same insulating material may be assumed to be for practical purposes, directly as the square root of the semi-diameter of the wire and inversely as the square root of the thickness of the insulating envelope.

Hence by increasing the diameter of the wire and the thickness of insulating covering, in the same proportion, the amount of inductive discharge remains the same. The force of the current in a voltaic circuit increases as the square of the diameter of the wire (the length of circuit being constant and the resistance of the battery being incon-

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siderable as compared with that of the metallic portion of the circuit), consequently if it be found inconvenient to increase the wire and the insulating covering proportionately, greater advantage will be obtained by increasing the diameter of the wire than the thickness of insulating covering, for whilst the covering remains the same, the induction discharge increases only as the square root of the diameter of the wire, whilst the force of the current increases as the square of the diameter; and if the insulating covering be varied, the conducting wire being constant, the strength of the current will remain the same, but the induction will only decrease as the square root of the thickness.

6. *a.* That india rubber surpasses all other materials in the smallness of the amount of its inductive discharge and the perfectness of its insulation. In the former respect a coating of india rubber is fully equal to a coating of ordinary gutta percha of double its thickness.

b. That Wray's compound, an artificial composition formed by the addition of other highly insulating materials to india rubber, and the newly manufactured pure gutta percha, closely resemble india rubber in both particulars.

c. That the mixture of imperfectly conducting materials with gutta percha, as carbon in Mr. Radcliffe's composition, or pounded cocoa-nut shell as in Mr. Godefroy's, has the disadvantage of greatly reducing the insulation and increasing the induction.

d. That the interposition of cotton thread between the wire and an india rubber coating, as in Hall and Wells' preparation, also considerably increases the induction and diminishes the insulation. The induction is augmented because the cotton thread, which is a bad insulator, increases the surface of the conductor; and the insulation is impaired, not only because the insulating coating is diminished, by the thickness of the cotton, but probably also in consequence of the greater inductive action. The interposition of cotton between two layers of gutta percha is equally disadvantageous, as is proved by the experiments on Mr. Hearder's short line of 450 yards.

e. That the interposition of a viscid insulator between two coatings of gutta percha neither decreases the induction nor improves the insulation of the line. If Mr. Hughes' process should possess any advantage, it will be found in the tendency of the viscid fluid to fill up air holes or flaws in the gutta percha coatings.

f. Generally speaking the more perfect the insulating property of the material is, the less is its inductive capacity. There are, however, several apparent exceptions to this rule among the experiments made, but there are so many causes to affect the experiments on insulation, that we are not warranted to infer, from these exceptions, the entire independence of the two properties.

7. Temperature affects the discharge only in so far as it affects the insulation.

8. It does not appear that pressure exerts any influence on the amount of induction discharge.

The velocity with which electricity travels through a metallic wire is exceedingly great; indeed, for practical purposes, instantaneous, when there is no induction. The well-known experiments of Professor Wheatstone, which were made with electricity of high tension, proved that this velocity is not inferior to that with which light travels through the planetary space; and the most reliable experiments which have since been made with electricity of comparatively low tension, which is more affected by adventitious circumstances, still give a very high speed. Messrs. Fizeau and Gounelle ascertained the velocity of electricity generated by a voltaic battery to be in copper wire 111,834 miles per second, and in iron wire 62,130 miles per second; and the more recent experiments of Messrs. Guillemin and Burdouf give the velocity in iron wire to be 111,847 miles per second. Messrs. Fizeau and Gounelle inferred from their experiments that the velocity of electricity is independent of the strength of the current and the section of the conductor, though it varies with the material.

Other experiments have been made, from which a much lower velocity has been concluded; but these have generally been on subterranean lines, in which the retardation has been proved to be owing to the inductive action of the surrounding medium, from which they are separated by an insulating covering. In these cases it is not the velocity of the electricity in the metal which is measured, but the time which is required for a certain amount of effect to be produced at the remote end of the wire, or, in other words, the time necessary to charge the wire to a certain amount. Most electricians who have considered this matter in a theoretical point of view concur in stating that this time is proportional to the square of the length; many attempts have been made to prove this law, but satisfactory experiments, free from error or ambiguity, are still wanting.

Dr. Faraday, from some experiments made by Mr. Clark, gives two seconds for the time which the current requires to appear at the remote end of a subterranean telegraphic wire 1,500 miles in length, whilst in the same length of air wire the time was almost inappreciable. Mr. L. Clark states the time at which the current appeared at the distant end of a subterranean wire 788 miles in length was three-eighths of a second, whatever was the battery power employed; and, with regard to the Atlantic cable (before it was submerged), Mr. Walker states the interval between the electric force being communicated at one end and arriving at the other to be about two seconds. It is stated that Professor Thompson's delicate reflecting galvanometer showed a sensible current in less than one second.

If a measured charge, after its transmission through the wire, were discharged at the remote end in an equal interval of time, this retardation would be of little importance, as the charges at one end and the discharges at the other would succeed each other in the same order and with the same intervals between them; but as the discharge in great lengths of wire occupies a much greater time than the charge, if a new charge is given before the wire is completely cleared of the former, although the charges may be separated by strongly marked intervals, the discharges would be confounded into one, and it would be impossible to distinguish the various succession of currents, which represent the alphabetic characters, from each other. There is thus a limit to the number of signals which may be made in a given time, dependent on the inductive action brought into play on the line.

Various expedients have been resorted to, to increase the rapidity with which currents may be made to succeed each other; the one most generally employed is to discharge the near end of the line immediately after it is disconnected from the battery, before another current is sent into it. Mr. Varley and Messrs. Siemens, instead of discharging the return current into the earth, neutralize it by bringing the wire into contact with the pole of a weak battery, which produces a weak current in the opposite direction. Professor Jacobi employs a secondary battery, which, becoming polarized or charged by the transmitted current, occasions a current in the opposite direction, which acts during the cessation of the primary battery current and neutralizes the residual electricity in the wire.

Professor Hughes has made a number of experiments on submarine cables (before they were immersed) to ascertain the number of alternating currents he could pass through them in a given time, so that the signals should not be confused at the opposite end; he calls the succession of two alternating currents a wave. The results he obtained are stated in his evidence.

(To be continued.)

MAZER WOOD: GUTTA PERCHA.

In the *Musæum Tradescantianum, or a Collection of Rarities preserved at South Lambeth, near London*, by John Tradescant, 1656, I find, amongst "other variety of rarities," "the pliable Mazer wood, which, being warmed in water, will work to any form;" and a little farther on, in the list of "utensils and household stuffe," I also find "Mazer dishes." In my opinion, it is more than a coincidence that Doctor Montgomery, who, in 1843, received the gold medal of the Society of Arts for bringing gutta percha, and its useful properties, under the notice of that body, describes it in almost the same words that Tradescant uses when speaking of the pliable Mazer wood: the Doctor says, "it could be moulded into any form by merely dipping it into boiling water." It is worthy of remark that Tradescant, who was the first botanist of his day, seems to have been uncertain of the true nature of the "Mazer wood," for he does not class it with his "gums, rootes, woods;" but, as before observed, in a heterogeneous collection which he styles "other variety of rarities." Presuming, as I do, that this Mazer wood was what we now term gutta percha, the question may be propounded, how could Tradescant have procured it from its remote *locale?* The answer is easy. In another part of the *Musæum Tradescantianum* may be found a list of the "benefactors" to the collection; and amongst their names occurs that of William Curteen, Esq. Now this William Curteen, and his father Sir William, of Flemish descent, were the most extensive British merchants of the time, and had not only ships trading to, but also possessed forts and factories on, some of the islands of the Eastern Archipelago, the native *habitat* of the sapotaceous tree that yields the gutta percha. Curteen was a collector of curiosities himself, and no doubt his captains and agents were instructed to procure such; in short, a specimen of gutta percha was just as likely to attract the attention of an intelligent Englishman at Amboyna in the fifteenth century, as it did at Singapore in the nineteenth.

If there are still any remains of Tradescant's collection in the Ashmolean Museum at Oxford, the question, whether the Mazer wood was gutta percha or not, might be soon set at rest; but it is highly probable that the men who ordered the relics of the Dodo to be thrown out, showed but little ceremony to the Mazer wood or dishes.

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A curious instance of a word, not very dissimilar to Mazer, may be found in Eric's Red Saga, part of the *Flato Annals*, supposed to be written in the tenth century, and one of the authorities for the pre-Columbian discovery of America by the Icelanders. 'Karlsefne, one of the heroes of the Saga, while his ship was detained by a contrary wind in a Norwegian port, was accosted by a German, who wished to purchase his, Karlsefne's, broom.

"'I will not sell it,' said Karlsefne. 'I will give you half a mark in gold for it,' said the German man. Karlsefne thought this a good offer, and thereupon concluded the bargain. The German man went away with the broom. Karlsefne did not know what wood it was; but it was *Mœsur*, which had come from Wineland!"

Perhaps some reader may give an instance of Mazer wood being mentioned by other writers: or inform me if the word Mazer, in itself, had any peculiar signification.—*Notes and Queries.*

BAROMETER CARD AND STORM-WARNING SIGNALS.

[We are favoured with the following interesting and useful meteorological information, by Admiral Fitzroy.]

The Barometer Rises for Northerly wind,	The Barometer rises for Southerly wind,
(including from North-west, by the *North*, to the Eastward),	(including from the South-east, by the *South*, to the Westward)
for dry, or less wet weather—for less wind—or for more than one of these changes:—	for wet weather—for stronger wind—or for more than one of these changes:—
Except on a few occasions when rain (or snow) comes from the Northward with *strong* wind.	Except on a few occasions when *moderate* wind with rain (or snow) comes from the Northward.
For change of wind towards *any* of the above directions—	For change of wind towards the *upper* directions *only* (Southerly)—
A thermometer falls.	A thermometer rises.

Moisture, or dampness, in the air (shown by a hygrometer), increases before, or with rain, fog, or dew.

On barometer scales the following contractions may be used in *North* latitude:—

RISE	FALL
FOR	FOR
N. Ely.	S. Wly.
NW.–N.–E.	SE.–S.–W.
DRY	WET
OR	OR
LESS	MORE
WIND.	WIND
EXCEPT	EXCEPT
WET FROM	WET FROM
N. Ed.	N. Ed.

And the following Summary may be used *generally* throughout the world:—

RISE	FALL
FOR	FOR
COLD	WARM
DRY	WET
OR	OR
LESS	MORE
WIND.	WIND.
EXCEPT	EXCEPT
WET FROM	WET FROM
COOLER SIDE.	COOLER SIDE.

Storm-warning Signals.

A staff and two canvas shapes being provided, the following use will be made of them occasionally; perhaps once or twice in a month, on a yearly average.

One shape, that of a drum (or cylinder) has the appearance of a black square of (not less than) three feet (seen from any point of view) when suspended.

The other shape, a cone (not less than) three feet high, appears triangular (from any point of view) when suspended.

A cone, with the point upwards, shows that a gale is *probable;* at first from the *northward.* North Cone.

A cone, with the point downwards, shows that a gale is *probable;* at first from the *southward.* South Cone.

A drum, alone, shows that stormy winds may be expected from nearly opposite quarters successively.

A cone and drum give warning of dangerous winds, the probable *first* direction being shown by the position of the cone, point up, above the drum, for northerly (or polar) wind, point down, and below the drum, for southerly.

Whenever such a signal is shown (in consequence of a telegram from London) it will be kept up, distinctly, till dusk of *that day only*, unless otherwise specially directed.

These cautionary signals advert to winds during some part of the next nights and two or three days; therefore due *vigilance* should prevail (until the weather is again settled), without deferring *departures* or any operations *unnecessarily.*

A conspicuous place should be selected for signalling; near the telegraph station; whence other places may repeat the signal, or be warned.

If practicable the signal pole or staff should be in view of seafaring persons, and of the nearest coast guard.

When both these objects cannot be attained without too great distance from the telegraph station, one only—that of visibility to some of the seafaring community—should be secured; and in this case a message should be sent to the nearest coast guard, and charged to this department at the authorized tariff.

Further notice may be given by *local interests* and *authorities*, as London can only warn principal outposts. The coast-guard may repeat the warning as far as means allow, and *extension* of such cautionary notices can be effected by *private* assistance along the most *frequented* shores, where alone they are required.

When a cautionary telegram is *received*, at any place, *after* three o'clock p. m., it should be followed by a Night signal; which should be hoisted at dusk, and kept up till about midnight.

It should be remembered that only the greater and more *general* disturbances of the atmosphere can be made known by this method, not merely local or sudden changes which are not felt at a certain distance, and do not therefore affect other localities. Local changes may be indicated to observers at such places, by their own instruments, by signs of the weather, and by due consideration of the Weather Reports for a few previous days.

Much inequality of electricity, atmospheric pressure (or *tension*), or temperature; great fall or rise of the barometer; sudden or rapid alternations; great falls of rain or snow, foretell more or less wind, with its usual accompaniments, either in some places only, or throughout an extensive area of hundreds, if not thousands, of miles. Some tracts, however, being unaffected.

Speaking *generally*, there is far less occasion to give warning, of *southerly* gales, by signals, than of northerly; because those from the southward are preceded by notable signs of the atmosphere, such as a falling barometer, and a temperature higher than usual *at the season;* whereas, on the contrary, dangerous storms from a polar quarter (north-west to north-east) are sometimes sudden, and often are preceded by a *rising* barometer, which may mislead persons, especially if accompanied by a temporary lull of a day or two, with a fallacious appearance of fine weather. This fallacy is caused by one circuit, or cyclone, following and influencing a preceding similar, though probably inferior movement).

It should be kept in mind, that these signals are merely *cautionary*, to give notice of much atmospheric disturbance over some considerable part of the British Islands, without being in the least degree *compulsory*, or interfering with individual judgment on any occasion.

PHOTOGRAPHIC SPECTRA OF THE ELECTRIC LIGHT.

BY DR. MILLER, F.R.S.

The apparatus by which the spectra may be photographed consists of an ordinary camera obscura attached to the end of a long wooden tube, which opens into a cylindrical box, within which is a prism glass, or a hollow prism filled with bisulphide of carbon. If the prism be so adjusted as to throw the solar rays, reflected from a heliostat upon the screen of the camera, and the wires which transmit the sparks from Ruhmkoffer coil, are placed in front of the uncovered portion of the slit, the two spectra are simultaneously impressed. The solar beam is easily intercepted at the proper time by means of a small screen, and the electric spectrum is allowed to continue its action for two or three, or six minutes, as may be necessary. He did not find that anything was gained in distinctness by interposing a lens of short focus between the slit and the wire which supplied the sparks, with the view of rendering the rays of the electric light parallel like those of the sun, owing to the absorbent action of the glass weakening the photographic effect; and the flickering motion of the sparks being magnified by the lens, rendered the lines less distinct than when the lens was not used. Although with each of the metals (including platinum, gold, silver, copper, zinc, aluminum, magnesium, iron), when the spark was taken in air, he obtained decided photographs. It appeared that in each case the impressed spectrum was very nearly the same, proving that few of the lines produced were those which were characteristic of the metal. The peculiar lines of the metal seemed chiefly to be confined to the visible portion of the spectrum, and these had little or no photographic power. This was singularly exemplified by repeating

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the experiment upon the same metal in air, in a continuous current of pure hydrogen. Iron, for example, gave, in hydrogen, a spectrum in which a bright orange and a strong green band were visible, besides a few faint lines in the blue part of the spectrum. Although the light produced by the action of the coil was allowed to fall for ten minutes upon a sensitive collodion surface, scarcely a trace of any action was procured; whilst, in five minutes, in the air, a powerful impression of numerous bands was obtained. It was remarked by Mr. Talbot that, in the spectra of coloured flames, the nature of the acid did not influence the position of the bright lines of the spectrum, which he found was dependent upon the metal employed, and this remark had been confirmed by all subsequent observers. But the case was very different in the absorption bands produced by the vapours of coloured bodies—there the nature of both constituents of the compound was essentially connected with the production of absorptive bands. Chlorine, combined with hydrogen, gave no bands by apsorption in any moderate thickness. Chlorous acid and peroxide of chlorine both produced the same set of bands, while hypochlorous acid, although a strongly coloured vapour and containing the same elements, oxygen and chlorine, produced no absorption bands. Again, the brownish red vapour of perchloride of iron produced no absorptive bands; but when converted into vapour in a flame this gave out bands independent of the form in which it occurred combined. These anomalies appeared to admit of an easy explanation of the supposition that, in any case, the compound is decomposed in flame, either simply by the high temperature, just as water is, as shown by Grone, or, in all other cases of the production of bright lines by the introduction of a metallic salt into a flame of burning bodies (as shown by Deville). In the voltaic pole the decomposition must of necessity take place by electric action. The compound gases, protoxide and binoxide of nitrogen, gave, when electrified, the same series of bright bands (as Plücker had shown), which their constituents when combined furnish. Aqueous vapour always gives the bright lines due to hydrogen and hydrochloric acid, the mixed system of lines, which could be produced by hydrogen and chlorine. The reducing influence of the hydrogen and other combustible constituents of the burning body would decompose the salt, liberating the metal, which would immediately become oxidised or carried off in the ascending current. There was obviously a marked difference between the effect of intense ignition upon most of the metallic and non-metallic bodies. The observation of Plücker upon the spectra of iodine, bromine, and chlorine show that they give, when ignited, a very different series of bands to those which they furnished by absorption, as Dr. Gladstone had already pointed out; but it was interesting to remark that in the case of hydrogen which, chemically, was so similar to metal, we have a comparatively simple spectrum, in which the three principal bright lines correspond to Fraunhofer's dark lines, C, F, and G. It was, however, to be specially noted that the hydrogen occasioned no perceptible absorption bands at ordinary temperatures in such thickness as we could command in our experiments, and the vapour of boiling mercury was also destitute of any absorptive action, although when ignited by the electric spark, it gave a characteristic and brilliant series of dark bands. The following experiment suggested itself as a direct test of Kirchoff's theory. Two gas-burners, into which were introduced chloride of sodium on the wick of the spirit lamp, were placed so as to illuminate equally the opposite sides of a sheet of paper partially greased. The rays of the electric light screened from the photometric surface, suitably protected, were made to traverse one of the flames. If the yellow rays of the light were absorbed by the sodium flame, the light emitted laterally by the flame should be sensibly increased. The experiment, however, failed to indicate any such increase in the brilliancy of the flame, possibly because the eye was not sufficiently sensitive to detect the slight difference which was to be expected.

THE ELECTRIC TELEGRAPH.

I have just met with a passage in the *Pseudodoxia Epidemica* of Sir Thomas Browne, wherein this invention is foreshadowed in terms more remarkable and significant, if less imaginative and beautiful, than that from *The Spectator*, to which public attention has already been directed, and which, I conceive, must unquestionably have been written, with this particular example of the "received tenets, and commonly presumed truths" of the learned physician's day, distinctly present to the mind of Addison. The passage referred to is as follows.—

"There is another conceit of better notice, and *whispered thorow the world* with some attention; credulous and vulgar auditors readily believing it, and more judicious and distinctive heads not altogether rejecting it. The conceit is excellent, and, if the effect would follow, somewhat divine; whereby we might communicate like spirits, and confer on earth with Menippus in the moon. And this is pretended from the sympathy of two needles touched with the same loadstone, and placed in the centre of two abecedary circles, or rings with letters described round about them, one friend keeping one, and another the other, and agreeing upon the hour wherein they will communicate. For then, *saith tradition*, at what distance of place soever, when one needle shall be removed unto any letter, the other, by a wonderful sympathy, will move unto the same."—Book II., chap. ii., 4to, 1669, p. 77.

Thus it is that "coming events cast their shadows before;" and, in the present case, one is curious to learn how far back the *shadow* may be traced. By whom has this *conceit* been *whispered thorow the world*? and in what musty tomes is that *tradition* concealed, which speaks concerning it? Kircher's *Catena Magnetica* might haply tell us something in reply to these inquiries.—*Notes and Queries.*

THE SINGLE-NEEDLE TELEGRAPH.

Messrs. Wheatstone and Cooke's single-needle telegraph, patented May 6th, 1845, is shown in Fig. 415. The essential part of the instrument is composed of a single multiplier, with an indicator fixed vertically on a horizontal axis, and moving in front of a dial plate. This indicator may be either a light strip of wood, or a magnetic needle; if the latter, its poles must be in a reversed position to those of the needle within the bobbin. When the voltaic current is sent through the coil, the needle is deflected to the right or to the left,

Fig. 415.

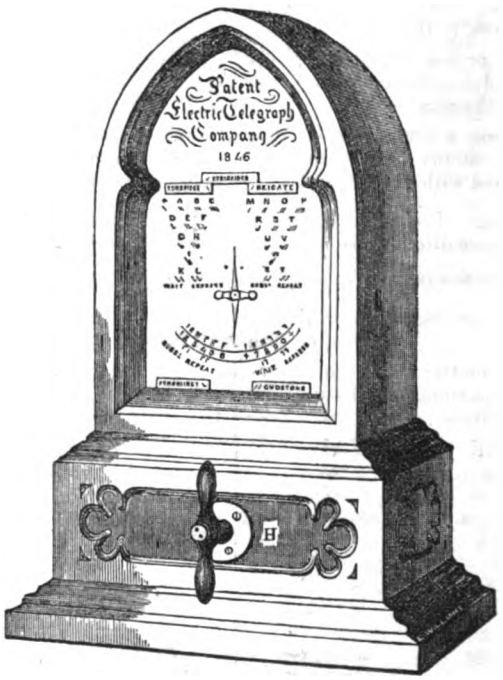
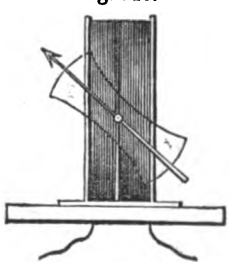


Fig. 416.



according to the direction in which the current passes. The alphabet is situated both on the right and the left hand side of the needle; some letters require 4 movements of the needle, but the last motion which completes the indication of a letter situated on the right hand side is always a movement to the right; in like manner the last motion which completes the indication of a letter on the left

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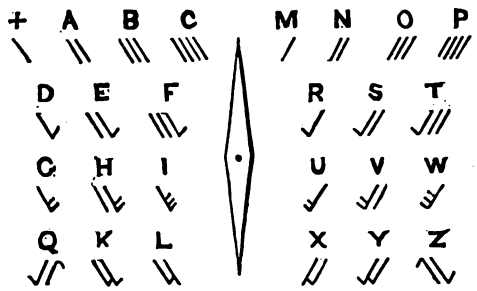
side is always a movement to the left; for example—the letter W is indicated by 4 motions of the needle, 3 to the left and 1 to the right; the letter L also is indicated by 4 motions, first to the right, then to the left, then again to the right, and finally to the left.

The code of signals adopted is shown in the following diagram; and bearing in mind that the deflections of the symbols for each

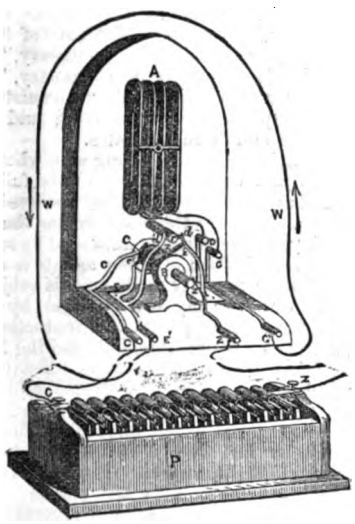
Fig. 417.



letter commence in the direction of the short marks and end with the long ones, it will be seen that the deflections of a single needle may be made to denote all the letters of the alphabet.

The numerals are inscribed on the dial underneath the needle, and are indicated by the movements of its lower half; for example—the figure 4 is designated by the motion of the lower extremity once to the right and once to the left; the figure 9 by a movement once to the left and once to the right, and so on. The internal mechanism of the telegraph is exhibited in Fig. 418. B A is the bobbin, in the interior of which is placed either a single magnetic needle, in the form of a rhomboid, 1⅛ inch long by ⅜ths of an inch broad; or which Mr. Walker found to be still better, several highly magnetized short

Fig. 418.



needles, firmly secured on either or both sides of a very thin ivory disc. The exterior or index needle is about 3 inches long. The frame of the coil, B, is made of copper, wood, or ivory; it is screwed to a plate of varnished copper against the side of the telegraph case. The copper wire surrounding the bobbin A is about $\frac{1}{120}$th of an inch in diameter, and is well covered with cotton; one end of the wire from the right hand bobbin is in contact with the screw G, which, by means of a metallic strap, is connected with the screw G′ secured on the base of the apparatus; the other end of the wire on the left hand bobbin is in contact with another screw, D, supported by a strip of brass which is fixed to the base; from this brass plate there rises an upright stiff steel spring *d*, which presses strongly against a point attached to an insulated brass rod, *r*, screwed against the side of the case; on the opposite side of this rod is another point against which a second stiff steel spring, *d′*, presses; this spring is attached to a brass plate, E, terminated by a binding screw E′; E′, therefore, is the screw terminal of the wire from the left hand coil. If G′ and E′ be now connected by a wire, W, the current will flow from G′ through G into the right hand coil, out from the left hand coil to D, thence through *d r d′* to E, and from the terminal screw E′, round the wire circuit, back to G′; and if the wire from G′ proceed *up* a line of railway, and the wire from E′ *down* the line, the circuit being complete throughout, the needle in the bobbin, A, will be deflected by a current proceeding from any station on the line, and thus signals will be communicated. Battery contact is broken and the direction of the current reversed by the action of the springs *d d′* in the following manner:—

B is a box-wood drum, moveable by a handle seen at H, in the front of the base of Fig. 415. Round either end of this drum are fixed the brass caps C and Z; the caps do not touch each other, a disc of box-wood being between them. Into these caps are screwed the steel projecting pieces C′Z′, which become the poles of the battery, the Z′ being connected with the zinc end, and C′ with the copper, thus: a wire, C, from the copper end of the battery conveys the current, C′C′, and a wire from the zinc end along Z, to a steel spring, which touches *z*, the continuation of the Z end of the box-wood cylinder. Now on moving the drum, by turning the handle, H, Fig. 415, the steel spring *d* will be raised from its corresponding point on *r*; the circuit will thus become broken, but by continuing the motion of the drum, the wire C will come into contact with the spring below it, and thus there will be a battery pole at either end of the drum, and signals will thus be made on the dial, and on all the instruments connected with it. The connexions are made in such a manner, that when the handle is turned to the right the needle moves to the right. The exterior, or indicating needle, is always placed with its N. pole upwards; that within the coil with its N. pole downwards; so that, in accordance with Oersted's fundamental law, looking at the face of the instrument, if we see the upper part of the needle moving towards the right, the spectator may be sure that the current is ascending in that half of the wire which is nearest to him.—*From Noad's Electricity.*

SPECIFIC GRAVITIES OF VARIOUS MATERIALS GENERALLY EMPLOYED IN THE CONSTRUCTION OF SUBMARINE CABLES.

Copper	8·8
Gutta percha...	9·725
India rubber...	9·25
Hemp...	1·061
Tar	953
Iron	7·64
Steel	7·85
Cork	0·240
Tin	7·3
Sulphur	2·
Tallow	0·942

Colonial and Foreign Telegraphy.

TELEGRAPHS.

The telegraph extension from Maitland to the northern boundary of the colony, was finished about two months since, but no use has yet been made of the extreme northern portion, in consequence of the non-completion of the wire through Queensland, which will connect our frontier with Brisbane. That line is now about finished, and probably this mail will carry to England the intelligence that the capitals of New South Wales, Victoria, South Australia, and Queensland, are united together by telegraphic communication. Mr. Cracknell, the Superintendent of Telegraphs, is at present inspecting the new line, and making arrangements for opening stations at Glen Innes and Tenterfield, those at Tamworth and Armidale having been opened.

Of the extensions carried out under the votes of last session, the only one not yet completed is that between Goulburn and Braidwood, a distance of sixty miles. The work is, however, in a very forward state, and the line is likely to be ready for opening this week—nearly six months within the time specified in the contract.

Several new extensions are proposed by the Government, the sums required for their execution being placed on the Estimates for 1862. These consist of lines to the Burrangong gold-fields, to Wollongong and Kiama, from Tenterfield to Grafton, and from Mudgee to Wellington. The direction to be taken by the two former of these lines is not stated, but it is probable that the wire to Burrangong will start from Bathurst and pass through Carcoar, and that the Wollongong wire will connect with the Southern line at Campbelltown.

Australian Telegraphs.—The estimate for telegraphs for the current year is £31,450.

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PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.—The market has assumed an animated appearance, being shown by the home trade at a public sale of about thirty tons, the purchase of all descriptions, at an advance upon last week's prices, as under:—

	s. d.	s. d.	
Genuine, mixed with decayed	1 7½	——	per lb.
„ „ more decayed	1 2	——	„
Light and decayed, mixed with inferior reboiled	0 9	0 10	„
A few tons of native manufacture from ordinary decayed "reboiled," mixed, and adulterated with sago, flour, ground bark, dirt, &c., readily taken for home consumption	0 7	——	„

India Rubber.—Limited transactions, but a very firm market. This week offered at public sale:—

	s. d.	s. d.	
586 Baskets Penang, good quality, bought in at	1 4	1 5	per lb.
266 Packages Para, fine quality, bought in at	1 9	1 10	„
Negro Head and run scrap, sold at	0 11½	——	„

December 19th, 1861. W. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do. B. 7 per cent. till 1862	all	18 to 19	——
20	Do. C. „ „	all	9 to 11	——
Stock	Electric Telegraph . .	100	93 to 95	——
20	Red Sea and India Telegraph	all	17½ to 18½	——
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	——
1	Do. registered . . .	all	3/8 to 5/8	——
10	Do. „	all	4 to 6	——
5	United Kingdom Telegraph	2	1d. par.	——
	Mediterranean Extension Tel.	all	3½ to 4½	——

Correspondence.

DEEP SEA TELEGRAPHS AND THE GREAT EASTERN STEAM SHIP.

To the Editor of The Electrician.

Sir,—The committee appointed to inquire into the construction of submarine cables, observe in their report, "It is important to avoid coiling or uncoiling a cable, when finished, more often than is absolutely necessary; and even its transferance from the ship, or from one ship to another is hazardous." Speaking of the mechanical operation of laying, the report adds, "The first requisite is that the ship should have a large amount of surplus power." * * * "The cable is laid in the hold of a vessel, in as large a coil as possible, and for this purpose there are but few which will allow space enough, hence all ordinary vessels require considerable modification. The space must evidently be perfectly clear, no cross beams from side to side of the vessel can be allowed. * * * It is therefore imperative, especially with a long cable, that the vessel employed should be a steamer of sufficient dimension to contain coals, and the cable for the whole voyage. A vessel capable of laying a cable weighing three tons per mile across the Atlantic, will have a load of 6000 tons, besides coals; and the clear space in her hold must be of sufficient dimensions for coiling this enormous length of cable. The hold must also be completely protected from the heat of the boilers. It is evident, therefore, that for such a purpose a vessel would have to be specially constructed, as no vessel existing, except the Great Eastern, would be adapted to the work." The report, in conclusion, recommends that "the ship should be of large capacity to admit of the cable being coiled easily without injury * * * it should be of a form to allow of the cable being paid out without any material alteration in the trim of the ship taking place; it should have sufficient power to enable it to maintain a speed of from four to six knots per hour in the direction in which it is proceeding in any weather, and it should be very steady in a rough sea. * * * We believe that a ship of the construction we have shown when not employed in laying cables, would be extremely useful for the ordinary purposes of commerce."

How well the *Great Eastern* answers to the above requirements, with its ample power, space, and steadiness. It is believed that most of the extensive lines of telegraphs which are lost were all more or less injured by frequent uncoiling, and by their stowage in ill-adapted and confined holds. The Malta and Alexandria cable very narrowly escaped being destroyed last summer, which occurrence must to some extent have affected its efficiency and durability. A noble opportunity presents itself for the successful development of ocean telegraphy, by securing the services of the *Great Eastern* for the purpose, either by Her Majesty's Government, or a *Great Eastern* Deep Sea Telegraph Company, consisting of some of our leading merchants.—Yours, &c.,

Eugenius.

PURIFICATION OF WATER.

To the Editor of The Electrician.

Sir,—I thank you for inserting in The Electrician of November 30, my letter on this subject, and also for your editorial note in answer to it.

From your reply I however perceive that you have mistaken what I said. It never occurred to me that the powerful oxidizing properties of the manganates and permanganates were only recently discovered, for they are, as you observe, mentioned in most modern chemical works. What I did say was that the remarkable purifying effects of the permanganates appeared to me to be a recent discovery, and I asked if it were known to whom this important discovery was due. A powerful oxidizing agent is not necessarily a disinfectant, therefore, although the purifying effects of the permanganates are to be explained by their oxidizing properties, it does not follow that the recognition of their oxidizing powers was equivalent to a knowledge of their disinfecting virtues. On referring to modern works on chemistry, I find on the one hand that the permanganates are not included in the lists of disinfectant agents given in them; and on the other, that in the sections of such works, which treat of the manganates and permanganates, the disinfecting properties of those bodies are not even hinted at. To this the "Handbook of Chemistry," of Abel and Bloxham (ed. 1854), forms no exception, since it does not contain any allusion whatever to a disinfecting use of these salts. Here is what I find at page 378 of that book, under the head of "Uses of Permanganates:" "Permanganate of potash is employed for the detection of sulphurous acid in officinal hydrochloric acid, and of the inferior oxides of nitrogen in nitric acid, since its very intense red colour is destroyed, with the greatest ease, by reducing agents. It also receives applications in the determination of iron in quantative analysis." Other standard works, such as Thomson's "Cyclopædia of Chemistry," Brand's "Dictionary of Science, Manufactures, and Arts," Graham's "Elements of Chemistry," Gregory's "Inorganic Chemistry," Fowne's "Manual of Chemistry," "Turner's Chemistry," by Liebig and Gregory, Muspratt's "Chemistry," &c., make no mention whatever of the possession of purifying and disinfecting properties by the manganates and permanganates.

As there was a time, and that not very long ago, when those properties were unknown, whereas now they would seem to be fully admitted, there must have been a period at which they were first observed, and some one at work on them observing. Who was the observer was the question I put in my former letter, which you have partially answered by saying that you believe that the practical introduction of these agents is dué to Mr. Condy. The researches which I have recently made on this subject, have enabled me to go further, and to answer my own question, by asserting that to Mr. Condy not only is due the first practical introduction of the manganates and permanganates as disinfectants, but also the first publication of the possession of purifying properties by those substances. In the last edition of Ure's "Dictionary of Arts and Manufactures," published in 1860, I had met with a distinct statement of the disinfectant value of the manganates and permanganates, which ends with these words: "Their use has been patented by Mr. Condy." The "English Cyclopædia" (1860), edited by Charles Knight, under the head of "*Infection*," contains the following: "Permanganates of soda and potash. These substances are powerful oxidizers. Whenever animal and vegetable matters exist in a state of decomposition, they oxidise the hydrogen and nitrogen, forming nitric acid and water. They are sold under the name of 'Condy's Disinfecting Fluid,' and are extremely useful, where solid or liquid infectious matters have to be dealt with."

It is therefore obvious that Mr. Condy is the discoverer of the disinfecting and purifying properties of the manganates and permanganates, and that the only application of those properties to the purification of water, which your article of 16th November chiefly dwelt upon, was one which he early pointed out and recommended.

Owing to your remark respecting some interesting articles having appeared on the subject in the *Pharmaceutical Journal*, I have looked over all the volumes of that work, but have not been able to meet with anything bearing on it, except a paper on the preparation of potash, in connection with the proposed administration of that salt internally in the treatment of diabetis.

This paper I found at page 18 of volume xiii. Surely this cannot be one of the interesting articles to which you alluded. In concluding I cannot help observing that neither of the authorities to which you have referred, afford even a hint of the purifying properties of the permanganates. I am, therefore, curious to know whether there are not other sources from which you obtained the information respecting those properties contained in your article of 16th November last. I am sir, your obedient servant,

December 12, 1861. F. N.

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[F. N.—All oxidizing agents must, in a greater or less degree, act as disinfectants; sulphuretted hydrogen, and the hydrocarbons generated during putrefaction, being reducing agents, or having a strong affinity for oxygen. Conversely, nearly every disinfectant which has been proposed, is an oxidizing agent. Chlorine and charcoal oxidize organic matter indirectly; the oxides of iron and manganese, chromic acid, manganic and permanganic acids, exercise the same action directly. The articles we referred to in the *Pharmaceutical Journal*, were not specially upon the action of the permanganates. We have not the work at hand; but, as far as we can remember, they appeared under the head of "Ozone and Autozone." The subject of the action of disinfectants, and of their employment upon a large scale, has only recently engaged attention, although charcoal and the oxide of manganese have long been employed for sweetening water, &c. According to Messrs. Hoffman and Frankland, and Messrs. Versmann and Rogers, the agent which from its cheapness and other properties is best adapted for practical use in disinfecting sewage, or water contaminated with the same, is "Dale's Permuriate of Iron." As we have already stated, the information contained in the article to which you refer, was obtained by actual experiment; but we really cannot state when and where we *first* heard of the employment of the permanganate salts as disinfectants. In the *second edition* of Abel and Bloxham's Chemistry, this application is briefly mentioned; and it has also been occasionally referred to in the *Engineer*, *vide* the number of January 11th, 1861, p. 28, where "Andy's manganate and permanganates," is evidently a misprint for "Condy's manganates," &c.—Ed.]

INSULATION AND TEMPERATURE.

To the Editor of The Electrician.

Sir,—In reading over the interesting tables in the appendix to the Government Report, I was much struck with the remarkable effect of increased temperature upon the insulating powers of various materials. As I have not seen the fact mentioned in the Report, I will with your permission call the attention of Electricians and manufacturers to the subject.

I believe that I should not be far wrong in stating that after a temperature of 42° the loss of insulation in gutta percha is nearly doubled by every additional increase of 10° of heat. The effect of this increase of temperature upon a gutta percha covered wire, when tested for dynamic electricity is exemplified in the following extract from Mr. Clark's table.

Temperatures.

	32	42	52	62	72	82	92
	°	°	°	°	°	°	°
Amount of loss upon a gutta percha covered wire	0	·0	·4	·9	2·1	4·8	9·5
Average of loss on 5 cores of gutta percha, of 1 mile in length, each ...	·2	·2	·34	·64	1·9	3·6	7·7

Upon referring to the experiments of Mr. Fleeming Jenkin, I find the loss of insulation at a temperature of 49°, on a gutta percha covered wire was 3·1°, and upon the same wire under a temperature of 59°, the loss increased to 6·4°, at 52½° = 3·48° increased, at 62½° to 7·24°, at 66½° = 8·18° increased, at 76½° to 17·12°.

In another table the same effect is produced by the increase of temperature.

Specific resistance of pure Gutta Percha.

Zinc to coil.		Copper to coil.	
Temp.	After electrification for one minute.	Temp.	After electrification of one minute.
°		°	
52	3548	52	3548
62	1934	62	1934
72	1001	72	999
82	497	82	477
	do. 5 minutes.		do. 5 minutes.
52	4654	52	4654
62	2242	62	2242
72	1103	72	1100
82	537	82	514

The following measurements also of the loss of insulation for static electricity upon various wires, subjected to increased temperatures, are extracted from Mr. E. I. Bartholomew's Tables (see page 357, appendix), which show a similar ratio of loss, as upon wires tested for dynamic electricity. The time the needle occupied in falling to half tension (viz., 512 cells to 256 cells), is taken in seconds as the measurement of resistance.

Description of Wires.	Temperature.						
	82	42	52	62	72	82	92
	"	"	"	"	"	"	"
Plain gutta percha	213	134	55	26	13	7	5
1. Special gutta percha, laid on in coatings, alternated with thin layers of Chatterton's compound	1,050	1,380	720	810	800	470	425
2. Another similarly covered wire, but with one half less thickness of coating . .	85?	555	298	177	102	60	30
3. Ratcliffe's, stated to be pure gutta percha, chemically prepared	25	46	30	22	15	7	5
4. Twenty alternate coatings of gutta percha and Chatterton's compound . . .	900	798	400	125	58	33	22
5. Hughes' core, gutta percha and fluid	200	102	40	14	8	5	5
6. Silver and Co.'s masticated india rubber	453	1,740	4,740	2,270	850	450	230
7. Hall and Wells' pure uncut para and masticated india rubber; the same thickness as special gutta percha wire No. 2. . . .	88	350	232	250	266	85	49
8. Wray's compound . .	about 10,000	9,100	3,000	2,027	520	240	128
9. Average of loss on 5 cores of gutta percha of 1 mile each in length	103	75	32	19	11	6	5

It appears that the special gutta percha covered wire No. 2, is an exception to the general rule. It reaches its maximum power at a temperature of 42°, and loses little less than one-third its charge atatemperature of 92°, while a sister wire, No. 8, with the same weight of copper, and half the thickness of coating, but of precisely the same materials, follows evidently the general rule. This difference is utterly inexplicable to me.

Something like the following decrease should have taken place so as to correspond with the ratio of loss on No. 8.

Temperatures.

	82	42	52	62	72	82	92
	°	°	°	°	°	°	°
No. 2.	1,050	1,380	720	810	800	470	425
Calculated	1,050	1,290	645	322	161	85	42

Messrs. Silver and Co's. india rubber core increases its insulating powers until it arrives at a temperature of 52°, when it decreases according to the amount of the increased temperature.

Wray's compound exhibits a very high insulating capacity under very low temperature, but falls rapidly when the temperature exceeds 42°.

Messrs. Hall and Wells, core B, reaches its maximum insulating power at a temperature of 42°, and sustains it to a considerable extent until the temperature is increased to 72°.

This wire had only a coating of $\frac{1}{8}$ of an inch in thickness, including a serving of cotton next the wire.

The twenty alternate coatings, and Hughes' core, seem to fall much in the same ratio. All the measurements for the loss for dynamic electricity were taken upon galvanometers, and for static electricity upon a Peltier electrometer fully described by the experimentalists.

I hope that the important question as to the relative value of insulating materials will be often, fully and fairly, discussed in your columns. That we possess materials eminently well adapted for ocean telegraphy is fully established, which having undergone the most searching severe and protracted tests without in the slightest degree exhibiting the least electrical deterioration, and time has now placed their durability beyond doubt. The public should understand this. There should be no mistake about the fact. Electricians, like doctors, will disagree; but the time must soon arrive when the voice of "public necessity will silence that of dissention, and claim for itself the right of applying the now efficient means which science has placed at its disposal for extending the incalculable advantages of electro telegraphy between us and distant shores without troubling itself about our "divided opinions." A Lover of Progress.

December 9, 1861.

ELECTRICAL ACARUS.

To the Editor of The Electrician.

Sir,—I have to thank you for kindly answering my questions relative to the Electrical Acarus.

In my letter I omitted one point, viz.: the *renewal* of a battery of six Daniells' cells (excited I presume in the usual manner), which you recommend for experiments with silicate of potash. Now in No. 5 of your

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Journal you state that it took eight months to produce the insect with fluo-silicic acid, and I do not think it could take much less time with silicate of potash.

If it does not take up too much of your space, would you inform me whether a momentary interruption of the current, to enable me to renew the battery, would affect any possible results, and if so, what would be the best way of effecting such renewal without interrupting or *disturbing* the action of the battery.

Being somewhat sceptical as to the production of the Acarus, I am anxious to give the experiments the best possible chance, and to try successively all the methods of producing the insect. I will certainly do myself the pleasure of informing you of my results (whether favourable or the reverse).—Your obedient servant, VIATOR.

[The interruption of the current may be avoided by having two batteries of 6 cells available for the experiment; making connection with the fresh battery previously to the removal of the battery requiring to be reconstructed.—E. E.]

To the Editor of THE ELECTRICIAN.

SIR,—If you or any of your readers would refer me to some works containing full particulars of any clocks, in which any form of electricity is the maintaining power, or will kindly point out the main difficulties to be overcome in clocks of this kind it would much oblige me.—Yours respectfully, W. S. R.

[Mr. Noad, in his valuable work, fully describes the various inventions for working clocks by electricity, see page 790.]

Miscellanea.

IN a case recently brought before the Chief Justice of Newfoundland, he decided that telegraph operators, when compelled to attend a judicial proceeding are bound to disclose the contents of messages; and that in so doing they do not at all violate the oath they have taken that they will not "wilfully divulge the contents of the messages.—*Manchester Guardian.*

A GOOD INSULATOR FOR A PELTIER.—Melt india rubber, resin, and gum dammar. It must be all pure, and well cleansed. Shellac may be substituted for resin. I have used this compound and found it very efficient.

PREACHING BY THE ELECTRIC TELEGRAPH.—"We have heard of all sorts of communications by means of the electric telegraph, from Queen's Speeches down to doctors' prescriptions, but I have not yet seen it proposed to introduce the agency of this new power into the pulpit. But why not? If, as beautifully observed in the sentiment toasted at a late American festive party, Franklin 'drew the lightning from heaven,' and Morse 'gave it voice, and bade it speak to the world,' why should not that voice be employed to spread Heaven's own 'glad tidings' throughout the world? The pulpits of a whole kingdom might be connected by telegraphic wires, and the exhortations of any celebrated preacher delivered at the same instant throughout the whole breadth and length of the land. It would but require a Reader in each pulpit (in place of Vicar or Curate) to carry this idea into practical effect."—B. H., Clapham, March 14.

THE ELECTRICIANS OF THE 18TH CENTURY.—It was about the middle of the eighteenth century that the science of electricity developed itself and made the most rapid advances. The following is a list of those who mostly contributed to its advancement: Gilbert of Colchester, author of "De Magnette," Dr. Franklin, the Hon. Mr. Boyle, Otta Guiericke, the famous inventor of the air pump, Dr. Wall, Sir Isaac Newton, Mr. Hauksbee, Mr. Stephen Grey, M. du Fay, Doctor Desaguiliers, Dr. Ludholf, Mr. Winkler, Mr. Gralath, Dr. Watson, Mr. Wilson, Mr. Smeaton, Dr. Miles, Abbéy Nollet, Mr. Canton, Beccaria in Italy, Delaval, Wilkes and Epinces, Dr. Priestley, Cigna of Turin, Symnier, Henly, Kinnersly, Nairne, Nooth, Lane, Ingenhouz, Dr. Van Marum, Fergusson, Lord Charles Cavendish, Walsh, De Luc, Partington, Birch, Adams, Lulling, Mahling, Wesley, Lovet, Gaffendus, Sir Kenllon Digby, Cavalho, Brook, Volta, &c.

CANADIAN IRON ORE.—In an account which appeared in the *Times* of the 26th inst., describing the loss of the Montreal steamship, *North Briton*, there is an interesting statement made relative to the occurrence of vast deposits of iron ore on Mingan, one of the Paroquite Islands in Gulf of St. Lawrence, near which the ill-fated vessel struck and foundered. The rocks in the vicinity are said to be so greatly impregnated with iron as seriously to affect the action of ships' compasses. If this observation be correct, it points not only to the existence of vast mineralogical treasure in these islands, but affords hopeful indications in regard to the quality of these beds of ironstone; since the magnetic ores are those which at the same time exert the most powerful attraction upon the compass needle, and are distinguished for their purity and freedom, especially from those contaminations which most seriously prejudice the quality of the iron when manufactured. The finest brands of Swedish and Russian iron are known to be smelted from ores of the magnetic oxide class, and iron is largely produced on the continent of North America from similar sources. Large supplies of pig iron from the adjoining territory of Nova Scotia have been brought into the English market; and it would be interesting to know whether the beds of ore referred to in the foregoing narrative, have hitherto been turned to practical account.

THE INVENTION OF THE ELECTRIC TELEGRAPH.—The following is a translation from a Madrid paper for 1790:—"The Prince of Peace, who testifies the most laudable zeal for the progress of the sciences, understanding that Dr. Don Francisco Salva had read at the Royal Academy of Sciences, at Barcelona, a memoir on the application of electricity to the telegraph, and presented at the same time an electrical telegraph of his own invention, requested to examine the apparatus himself. Satisfied with the exactness and celerity with which communications may be made by means of it, he introduced the doctor to the King of Spain. The Prince of Peace afterwards, in the presence of their Majesties and the whole court, made some communications with this telegraph, completely to their satisfaction. The Infant Don Antonio proposes to have one of them on the most complete construction, which shall possess power sufficient to communicate between the greatest distances, by land or sea. With this view, his Highness has ordered the construction of a machine, the cylinder of which is more than 40 in. in diameter; and he intends, as soon as it is finished, to undertake a series of curious and useful experiments, in conjunction with Dr. D. Salva. This is an employment worthy of a great prince."

TURNING SALT WATER INTO FRESH.—We hear of a discovery made at Adelaide which is much more satisfactory than news of fruitless, if not fatal, exploring expeditions to the interior of Australia. Mr. Neale of that city, while making certain chemical experiments, discovered a way to convert salt water into fresh water, by simply throwing in substances which produce a violent effervescence. On subsidence of the commotion a deposit takes place; the water is filtered off pure and palatable, and is, as our reporter says, preferred by many persons to the supply from the waterworks. Should it appear that the chemical substances required are inexpensive, and that the process is applicable on a large scale, this discovery will be particularly useful in parts of the country where salt lakes most prevail, and on board ships at sea. We have not heard whether Mr. Neale has made known what the required chemical substances are, but we commend the matter to the attention of sanitary functionaries. Its importance at the present time appears to be greater because of the endeavours now making in many places to provide the best water that can be got for household purposes. The artesian well at Passy, which has been bored to a depth of 577½ metres through difficulties that often hindered the work, and seemed at times insurmountable, now yields water enough to supply half a million of the population of Paris. It is remarkable that the opening of this well has diminished the supply of water to the one which has flowed copiously for many years at Grenelle.—*Chambers's Journal.*

FORMATION OF AMMONIUM AMALGAM.—Into a glass tube, open at both extremities, run a small portion of plaister, which, when hardened, forms a porous plug within the tube. A small quantity of mercury is then poured into the tube, and the latter placed in a vessel containing a concentrated solution of sal-ammoniac, a salt which may be regarded either as a muriate of ammonia, NH_3 HCC, or as a chloride of ammonium, NH_4 CC. The mercury is now connected with the negative pole of a voltaic couple, by means of a wire pointed with platinum, in order to avoid amalgamation of the conducting wire. The positive pole of the couple is connected with a plate of zinc immersed in the vessel containing the glass tube and solution. At the end of a few hours the mercury will be observed to have greatly increased in size, without, however, becoming in the least degree vesicular. The metallic substance formed, possessing the brilliancy of mercury with but a very small fraction of its specific weight, is supposed to be a combination of mercury, with the compound metal, *ammonium*.

To Correspondents.

THE MALTA AND ALEXANDRIA CABLE.—Several correspondents having expressed a wish to be informed of the actual electrical condition of the above line, we are sorry to state that we have not the means of affording the information. For the interest of science, and that of ocean telegraphy generally, it would be very desirable that "something should be known" of the condition of this important and extensive line. All must feel deeply interested in its success.

ELSINORE.—We believe that the first patent for insulating telegraph wires by means of gutta percha, was granted to J. Lewis Ricardo, Esq., M.P., in 1845 or 1846. The wires were imbedded in a thick strap or band.

A. B.—A great number of females are employed at the central station of the International and Electric Telegraph Company. The applications for employment are, we believe, exceedingly numerous.

HOUSEHOLDER.—Telegraph posts, when fixed upon roofs, should be furnished with lightning conductors. We believe that the companies adopt such a precaution in each case. A small yearly rent is generally paid for the privilege of erecting poles, &c.

PELTIER.—See advertisement on cover.

L. M.—The Malta and Alexandria is not, properly speaking, a *deep* sea cable. It lies mostly in shallow water, and not far from the shore. It is iron sheathed. The conductor is insulated in gutta percha and Chatterton's compound. The insulating material weighs 400 lb. to the mile, and the copper is of the same weight.

*** Several articles, including those under the head of "The Student," and "Earth Currents," have been deferred until next week.

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The Electrician.

Vol. I. No. 8.—December 27, 1861.

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BATTERY RESIDUES.

The question of the economical production of electricity is one which assumes a degree of importance commensurate with the actual and possible applications of this agency. In point of economy, as well as of efficiency, the substitution of the Daniell's battery for that in which free acid was allowed to be in contact with the zinc element, was a great step in advance. Other arrangements, similar in principle, and presenting many advantages, have recently been proposed; and some of these are under the consideration of the telegraphic officials in France. The principle is, that for each atom of the salt, in contact with the negative plate, which is decomposed by voltaic action *when the battery circuit is completed*, an atom of free acid passes through the porous diaphragm to act upon the positive metal. It has been found that an *insoluble* salt may prevent the polarisation of the negative element by the removal of the hydrogen gas evolved from it, and furnish the acid required for the removal of the oxide formed upon zinc, quite as well as one which is soluble; and thus an obvious means is afforded of altogether dispensing with the porous diaphragm required in the Daniell's cell. This advantage is well worthy of consideration; but, for some time to come, it is probable that the original "constant battery" will still hold its ground.

There is little prospect of the substitution of an equally efficient and less expensive positive for that afforded by the metal zinc, in the consumption of which battery expenditure principally consists. Iron, by which it has sometimes been replaced, has proved a failure even in an economical point of view; for, although pure iron gives an excellent positive, the combination of iron with carbon, met with in commerce, gives very unsatisfactory results. Until lately, the zinc consumed in the battery has been regarded as wholly lost; the sulphate salt being almost valueless. From this product, however, the metal may now be obtained by a comparatively inexpensive process; the cost of which should, in theory at least, determine the cost of battery power. With regard to the sulphate of copper, or other salt employed as an exciting agent; the reduction of the pure metal from a preparation of its ore should, if the price of the salt be not extravagant, defray the cost of this agent. Thus, the conversion to a profitable use of the sulphate of zinc generally obtained as a battery residue, may, at no very distant date, be an important element in determining the practicability of using electricity as a source of light, or even, in some cases, of heat and of motive power.

The process for obtaining the metal zinc from its sulphate, to which we have referred, was discovered by M. de Douhet, and published by him in the year 1859. It is based upon the powerful affinity of sulphuric acid of the earth baryta. When the sulphide of baryta is brought into contact with a solution of sulphate of zinc, double decomposition takes place, and a white insoluble compound is formed consisting of the sulphide of zinc (zinc blende), and the sulphide of baryta. This substance has been used as a paint, and, from its opaqueness, is superior in this capacity to the zinc paint commonly used. When the metal is to be obtained from it, the compound is mixed with 8 or 10 per cent. of its weight of coke, and the same quantity of chalk, and submitted to distillation, as would be an ordinary ore of zinc. At the same time that the zinc is reduced from its condition as sulphide, the sulphate of baryta is reconverted into sulphide; which may thus be employed, almost *ad infinitum*, for the decomposition of the zinc salt. It is to be observed that the zinc obtained by this process is chemically pure, and thus eminently adapted for voltaic purposes.

OCEAN TELEGRAPHY.

The publicity given to the various experimental tests carried on at Woolwich, Shoeburyness, &c., presents a favourable contrast to the apparent secrecy which has hitherto characterized the operations in submarine telegraphy. The public at large, but more especially those engaged in telegraphy, have long had reasons to complain of the absence of information upon a subject of so much national and scientific importance. The electrical tests have generally been conducted with the profoundest secrecy, especially with regard to the Malta and Alexandria cable. A successful submersion, or a failure, comprise the whole history of most of our extensive lines. Of the electrical condition of the cable when laid—whether it remain the same, or is improved or deteriorated, we are left in blissful ignorance. By a periodical publication of the actual working condition of the cable, the Government and the public would be able to judge how far they might depend upon its continued efficiency; besides, such publicity would afford our scientific men and manufacturers valuable data upon which they might proceed in experimenting and in devising improved methods and appliances for prevention of failures. Concealment creates distrust; on the other hand, publicity would inspire confidence. In connection with such an extensive line as the Malta and Alexandria, there must be a considerable amount of information, daily and hourly derived, and which would be of great practical value to those employed in electrical investigations. A science, still in its infancy, requires for its successful development the co-operation of all devoted to its study. The causes which have led to so many disastrous failures can only be removed by being known, and it is urged that most, if not all those failures, might have been avoided had we possessed the knowledge and means which subsequent researches and experiment have placed at our disposal.

It is utterly inconsistent with the spirit of progress to withhold information which is essential to the success of Ocean Telegraphy, or any other beneficial undertaking; and it is to be hoped that Her Majesty's Government will grant the publicity which has been so desirable in the present state of submarine telegraphy. The enormous expense incurred in constructing, laying, and testing, the Malta and Alexandria cable renders it peculiarly desirable that its working condition should be from time to time made known for the interest of science, and for the satisfaction of the paying public.

The line has been in active operation for several weeks, as we sincerely trust it may continue to be for several years; still the numerous enquiries addressed to us sufficiently prove that the absence of any statement of an encouraging kind, is a cause of regret and some anxiety. The movements of the "Warrior" or the "Great Eastern" are fully recorded in the daily papers, why should not the same publicity be given to the operations of an equally important agent in accelerating our interchange of thought and information, and more especially at a time when ocean telegraphy occupies so much public attention.

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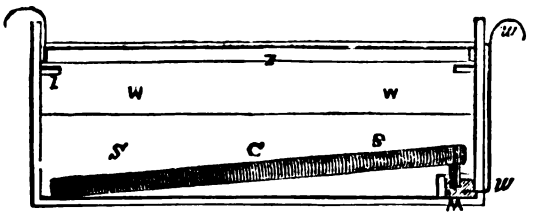
AN IMPROVED FORM OF SULPHATE OF MERCURY BATTERY.



The Marie-Davy battery, in which the insoluble subsulphate of mercury replaces the sulphate of copper of the Daniell's cell, has been used in France with very favourable results, especially upon the longest lines of telegraph. In the *Annales Télégraphiques* its comparative advantages are summed up as follows:—"An equal simplicity of construction, no attention for its maintenance while there remains any of the sulphate salt to be decomposed, materials wholly consumed with the production of a useful effect, action constant, and of longer duration, electromotive force greater, rendering necessary the employment of a smaller number of couples in producing the same result, preservation of the porous jars, compensation for the additional outlay by the greater duration of materials, and by residues which may be collected and utilized; such are the advantages which appear to be obtained by the sulphate of mercury battery compared with that of Daniell; advantages which will render the former particularly useful for the service of long telegraph lines."

In the Marie-Davy battery, however, the porous jar, which, by reason of the insolubility of the exciting medium might be dispensed with, is retained. The difficulty of making a perfect and permanent connection with the graphite which forms the negative element of the couple, has hitherto prevented the adoption of a different arrangement. In the battery couple represented above, contrived by Mr. D. G. Fitz-Gerald, this difficulty has been overcome. A projecting piece upon the graphite element C, fits into a cell at M, containing a small quantity of mercury. A wire or strip of copper, w w, passes from the outside of the ebonite battery vessel to the mercury cell, establishing a perfect contact with the carbon element. Upon this rests the insoluble sub-sulphate of mercury, S S; the zinc element Z, immersed in pure water, or in a weak solution of sulphate of zinc being superposed, and resting upon the ledge *l*. The inclination of the graphite element allows the mercury reduced upon its surface to run off, and to collect at the bottom of the vessel. A battery of this construction remains in action without attention for a period of six months. For the graphite element pure mercury may be substituted, but the action appears to be more powerful when the former is used.

ELECTRICITY IN THE SEVENTEENTH AND EIGHTEENTH CENTURIES.

We presume it will not be uninteresting to our readers to be presented with an account of the various discoveries, in their chronological order, by which the science of electricity became known to the world during the seventeenth and eighteenth centuries, and *prepared the way* for those more magnificent results, which have been made in this the nineteenth century. We will endeavour to make it as brief as is consistent with the importance of the subject, to enable us to mark the succession of discoveries and improvements through two hundred years.

More than any other branch of experimental philosophy, that of electricity had been most neglected until the seventeenth century. The attractive power of amber was mentioned by Theophrastus and Pliny, and also later by others.

In the year 1600, William Gilbert, a native of Colchester, and a London physician, published a Latin Treatise, *De Magnete*, in which he relates a variety of electrical experiments. He increased the list of electric bodies, and also of substances upon which electrics could act, and noted some of the circumstances relating to their action. His theory of electricity was, however, very imperfect.

In 1630, Nicolaus Cabœus, at Terrara, repeated Gilbert's experiments, and made some progress, increasing the list of electrics: as also did Mr. Boyle, in the year 1670. He made some discoveries which had escaped the observation of those who preceded him. Contemporary with Mr. Boyle, Otto Guericke, burgomaster of Magdeburg (inventor of the air pump), made some advances. He constructed a sulphur globe, which he mounted upon an axis, in a wooden frame, and causing it to revolve, at the same time rubbing the globe with his hand, performed a variety of electrical experiments. He was the first to discover that a body once attracted by an excited electric, was repelled by it, and not again attracted until it had touched some other body. He observed the light and sound produced by the electric fluid, while turning his electrical machine. Dr. Wall about the same time observed the light and sound produced by rubbing pieces of amber with wool, and also experienced a slight shock. He compared the sound and light of the electric fluid so produced, to thunder and lightning.

Sir Isaac Newton also engaged in similar electrical experiments, and gave an account of them to the Royal Society in 1675. Mr. Hauksbee, whose writings are dated 1709, distinguished himself by experiments and discoveries in electrical attraction, and repulsion, and electric light. He constructed an electrical machine, adopting the glass, instead of the sulphur globe. He experimented upon the subtility and copiousness of the electric light, and likewise upon the sound and shocks produced by the fluid. After the death of Mr. Hauksbee, the science of electricity made but slow progress, and few experiments were made for twenty years. In the year 1728, Mr. Stephen Grey, a pensioner at the Charter House, commenced his experiments with an excited glass tube. He and his friend, Mr. Wheeler, made a great variety of experiments in which they demonstrated, that electricity may be communicated from one body to another, even without being in contact, and in this way, may be conducted to a great distance. Mr. Grey afterwards found that, by suspending rods of iron by silk or hair lines, and bringing an excited tube under them, sparks might be drawn, and a light perceived at the extremities in the dark. He electrified a boy suspended by hair lines; and communicated electricity to a soap bubble blown down from a tobacco pipe. He electrified water contained in a dish, placed upon a cake of resin, and also a tube of water. He made some curious experiments upon a small cup of water, over which, at the distance of an inch, he held the excited tube. He observed the water to rise in a conical shape, from which proceeded a light; small particles of water were thrown off from the cone, and the tube moistened.

Mr. Du Fay, intendant of the French king's gardens, repeated the experiments of Mr. Grey in 1753. He found that by wetting the pack-thread he succeeded better with the experiment of communicating the electric virtue through a line 1256 feet in length. He made the discovery of two kinds of electricity, which he called *vitreous* and *resinous;* the former produced by rubbing glass, and the latter from excited sulphur, sealing wax, &c. But this he afterwards gave up as erroneous. Mr. Grey, in 1734, experimented upon iron rods, and gave rise to the term *metallic conductors*. He gave the name, *pencil of electric light*, to the stream of electricity, such as is seen to issue from an electric point. He suggested the idea that the electric virtue of the excited tube was similar to that of thunder and lightning, and that it could be accumulated.

Dr. Desaguliers commenced his experiments in 1739. He introduced the term *conductor* to that body to which the excited tube conveys its electricity. He called bodies in which electricity may be excited by rubbing or heating, *electric per se;* and *non-electric* when they receive electricity, and lose it at once upon the approach of another non-electric. In the year 1742, several Germans engaged in this subject. Mr. Boze, a professor at Wittemberg, revives the use of Hauksbee's globe, instead of using Grey's glass tube, and added to it a *prime conductor*. Mr. Winckler substituted a cushion instead of the hand, which had before been employed to excite the globe. Mr. P. Gordon, a Benedictine monk, and professor of philosophy at Erford, was the first who used a *cylinder* instead of a globe. With his electrical machine he conveyed the fluid through wires 200 ells in length, and killed small birds. Dr. Ludolf, of Berlin, in the year 1744, kindled by electricity the *ethereal spirit* of Frobenius, by the excited glass tube; the spark proceeding from an iron conductor. Mr. Boze fired gunpowder by electricity. Mr. Gordon contrived the electrical star. Mr. Winckler contrived a wheel to move by the agency of the same fluid. Mr. Boze conveyed electricity from one man to another by a jet of water, when both were placed upon cakes of resin, six paces apart. Mr. Gordon fired spirits by a jet of water; and the Germans invented the electrical bells.

Mr. Collinson in 1745 sent to the Library Company of Philadelphia,

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an account of these experiments, together with a tube, and directions how to use it. Franklin, with some of his friends, immediately engaged in a course of experiments, the results of which are well known. He was enabled to make a number of important discoveries, and to propose theories to account for various phenomena, which have been universally adopted, and which bid fair to endure for ages.

In the year 1745, such was the attention given to the subject of electricity, that experiments upon it were publicly advertised and exhibited for money in Germany and Holland. Dr. Miles, of England, in the same year fired phosphorus by the application of the excited tube itself without the intervention of a conductor. It was at this period that Dr. Watson's attention was given to this subject. He fired air, made inflammable by a chemical process, and discharged a musket by the electric fluid. He made many experiments, some of which will be described as we proceed.

The year 1745 was made famous by the discovery of the *Leyden Phial* by Mr. Cunous, a native of Leyden. It appears also to have been discovered by Mr. Von Kleist, dean of the Cathedral in Camin about the same time. By this discovery, electricity could be accumulated and severe shocks given. Mr. Gralath, in 1746, gave a shock to twenty persons at once, and at a considerable distance from the machine. He constructed the electrical battery by charging several phials at once. Mr. Winckler, and also M. Monnier, in France, transmitted the electric fluid through several feet of water as a part of the circuit. M. Nollett, in France, killed birds and fishes by the discharge of the Leyden jars. Improvements were made by Dr. Watson, and others, in the Leyden phial, by coating the inside and outside of it with tinfoil. Abbe Nollett gave a shock to 180 of the guards in the king's presence; and at the grand convent of the Carthusians in Paris, the whole community formed a line of 3600 feet in length, by means of wires between them. The whole company upon the discharge of the phial, gave a sudden spring at the same instant. The French philosophers tried the same experiment through a circuit of persons, holding wires between them, two and a half miles in length. In another experiment the water of the basin in the Tuilleries was made a part of the circuit.

M. Monnier, the younger, to discover the velocity of electricity, discharged the Leyden phial through an iron wire 4000 feet in length, and another 1319 feet, but could not discover the time required for its passage. Dr. Franklin communicated his observations, in a series of letters, to his friend Collinson, the first of which is dated March 28, 1747. In this he shows the power of points in drawing and throwing off the electrical matter. He also made the grand discovery of a *plus* and *minus*, or of a *positive* and *negative* state of electricity. Shortly after, Franklin, from his principles of plus and minus state, explained in a satisfactory manner, the phenomena of the Leyden phial. Dr. Watson and others, on the 18th of July, 1747, conveyed the electric fluid across the Thames at Westminster Bridge; the width of the river making a part of the circuit. On the 24th of July he tried the experiment of forcing the electric fluid to make a circuit with the bend of the river, at the New River at Stoke Newington. He supposed that the electric fluid would follow the river alone, through its circuitous windings, and return by the wire. He suspected from the result of this experiment, that the ground also conducted the fluid. On the 28th, he proved the fact by supporting a wire 150 feet in length upon baked sticks, using the ground as half of the circuit. On the 5th of August he tried another experiments of making the *dry* ground a part of the circuit for a mile in extent, and found it to conduct equally as well as water. The last experiment was tried at Shooter's Hill, on the 14th of August, of the same year. But one shower of rain had fallen for the five preceding weeks. The wires, two miles in length, were supported upon baked sticks, and the dry ground was used for the return, two miles of the circuit. They found the transmission of the electric fluid to be instantaneous. Dr. Watson made many other experiments which we must pass over.

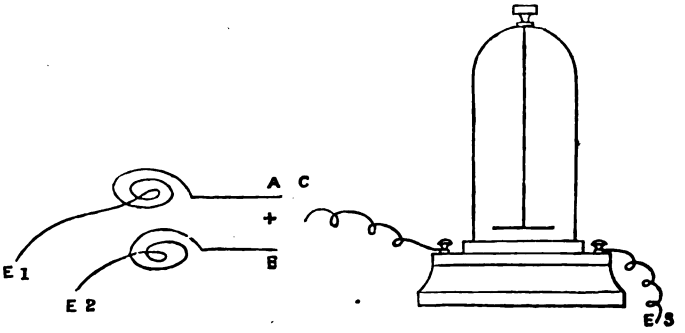
EARTH CURRENTS.—No. 6.

[Continued from p. 53.]

We readily fall into the views of our experienced correspondent, "An Old Hand." "Terrestrial Currents" would have been a more satisfactory definition of the various phenomena hitherto described. In our experiments we took the necessary precautions against being misled by *deflections* arising from the action of earth plates. We had hitherto employed a battery power of 502 elements; the following experiments relate exclusively to the action of earth plates, no battery being employed:—

We had for the purpose of these experiments two miles of gutta percha covered wires of one mile in length each. One had a copper conductor 4-32 of an inch in diameter, and a coating of 3-32 of an inch in thickness. The other mile had an iron conductor 4-32 of an inch in diameter, and a coating 3-32 of an inch in thickness. Both miles were placed upon the ground, and covered with a tarpaulin, one end of each mile being led into the experiment room, the other end to a large water tank. The galvanometer employed was a very delicate and reliable instrument. It is designated in government experiments as "Henley's large suspension galvanometer," and as having a resistance equal to.

The following *diagram* will better enable the reader to trace the various arrangements:—



A is the one mile copper-covered wire.
B is the one mile iron-covered wire.
C is a short leading wire to the galvanometer.
E^3 is also a short leading wire from galvanometer to earth.
E^1 is the earth plate attached to end of copper wire A.
E^2 is the earth plate attached to end of iron wire B.
+ A key was employed here to bring wires A or B into contact with C.

In the first experiment—
E^1 was a small coil of copper wire attached to end of A.
E^2 a small coil of iron wire attached to end of B.
E^3 attached to water pipe as earth plate.

When A was brought in contact with C the current passed between E^1 and E^3, and caused a deflection to the *right* of 32·2°.

When B was brought into contact with C, the current passed between E^2 and E^3, and caused a deflection to the *left* of 14°.

For E^2 a copper coil was now substituted, and the deflection was 26·3° to the *right*.

E^3 was now detached from water pipe, and a coil of copper substituted for an earth plate.

A and B still having the same earth plates as in previous experiment, were brought jointly into contact with C, causing the needle now to deflect 14° to the left. A alone gave a deflection of 10°, and B of 14°. When E^3 was re-attached to the water pipe, A gave a deflection 32°, and B of 26° to the right.

E^3 having been detached from the water pipe, and the same weight of copper wire as those of E^1 and E^2 attached thereto as earth plate, A gave now a deflection of 1° to the right, and B 6° to the right. A and B together, 3° to the right.

B gave a permanent deflection of 5°, but upon introducing a piece of zinc, so as to form the contact between the end of A wire and short C wire, the deflection was reduced to 3·5°, and the needle remained steady. A piece of iron wire of ten feet in length was now substituted for the zinc, as part of the circuit, the needle commenced to oscillate through an arc of 6 degrees, and continued to do so as long as the iron wire remained as part of the metallic circuit.

Our friend, "An Old Hand," will, maybe, some day favour us with his experience of currents generated by *soldered* joints, and when copper and iron wires form the continuity of the line.

The copper coil forming earth plate E^2 was now removed, and a measured coil of very thin copper wire substituted, E^3 remaining the same, the deflection on B now was only 2° instead of 6°. E^3 had a coil of the same copper the same length and weight substituted for the large coil. B still gave a deflection of 2°, but with a tendency to oscillate. A gave an increased deflection of 1·25. A piece of solid copper 1 oz. in weight was now substituted for thin wire of E^3. A's deflection increased to 10°, and B to 11°, both to the right. 1 oz. of zinc was substituted for the 1 oz. of copper, the deflection was 40° on A, and on B 39° to the right. A and B together 39°, which gradually increased in two hours to 44·5. When A was removed from contact, B gave a deflection of only 5°, which gradually increased to 7°, when the needle began to oscillate between 5° and 10°. A again brought in

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contact, the deflection was 54°, the needle remaining perfectly steady. B alone again gave 5°, but when thin wire of E^1 was exchanged fora coil of iron wire the deflection increased to 45°.

A was now furnished with copper of the same weight and quality as that attached to E^3 as earth plate. No deflection. B wire had in the like manner iron earth plates of the same size and quality similarly arranged. No deflection took place, but a tendency to oscillate.

The current developed by using the water pipes against the gas pipes was very powerful.

With a current so derived an insulated wire one mile in length, upon being charged, gave an induction discharge of 7°.

When a copper plate at one end, and an iron plate at the other were used, the action of the current was very irregular. In the course of three hours the deflections were read—34°, 31°, 30°, 32°, 20°, 33°, 38°, 35°, 30°, 31°, 32°, 28°, 29°.

The earth plates were immersed in water at a temperature of 54°, with the exception of the water and gas pipes.

The earth intervening between the plates was about fifty yards, superficial measurement.

In subseqnent experiments a given number of battery cells were employed in connection with earth plates of various description, and in which aërial wires, formed the long circuit.

(To be continued.)

WAR: THE OCCASION OF THE INTRODUCTION OF THE GALVANO-ELECTRIC TELEGRAPH.

Dr. Hamel, who has been indefatigable in the study of the history of the introduction of the galvanic and electro-magnetic telegraph, in his treatise, already quoted in our columns, gives the following account, showing that the war between Austria and France in 1809 gave occasion to the invention of the first galvanic telegraph:

"I have taken considerable pains to find out the origin of the first telegraph made to work by a galvanic battery. Through it the Russian Baron Schilling was induced to follow the art of telegraphing with enthusiasm, and he subsequently made at St. Petersburgh the first electro-magnetic telegraph, which, in a curious way, caused the introduction of such telegraphs in England.—That Soemmerring, in Germany, made a telegraph, in which the chemical, decomposing, action of the galvanic current on water produced the signals, is known, but nobody has taken the trouble to discover how he was induced to construct it. Even the time, when it was made, is nowhere accurately given. Often it is stated wrongly by one, two, three, and, in one case, by nine years. It is surprising that the highly meritorious Steinheil, who lives in the very town where Soemmerring had made the first galvanic telegraph, errs likewise by two years.

"From a minute and careful examination of the late Dr. Soemmerring's papers, I am enabled to state that in the months of July and August 1809 the first galvano-electric telegraph was made.

"Dr. Samuel Thomas von Soemmerring, whose merits as an anatomist and physiologist are universally known, was born in 1755 at Thun, and he deceased in 1830 at Frankfort-on-the-Maine. He had studied at the University of Göttingen. In the year 1778 he travelled in Holland, England and Scotland. From 1779 till 1784 he was at Cassel, and from 1785 till 1796 at Mayence, professor of anatomy. From 1796 to 1805 he practised medicine in Frankfort, and from 1805 till 1820 he was a member of the Academy of Sciences at Munich, where the King of Bavaria gave him the title of Privy Councillor (Geheimer Rath). From 1820, till his death in 1830, he practised again medicine at Frankfort. He had, in 1819, paid a prolonged visit from Munich to Frankfort, where, in the month of June, I had the pleasure of making his personal acquaintance. I find my visits mentioned in his diary. In 1805 Soemmerring very nearly became a resident member of the Imperial Academy of Sciences at St. Petersburgh, to fill the place vacant by the death of the physiologist Kaspar Friedrich Wolff.

"Soemmerring had, like Humboldt and others, taken an interest in galvanism, chiefly with the hope of being able to make its study useful to clear up some of the most mysterious portions of physiology. I find, however, that he had already in November 1801 paid attention to the chemical action of the galvanic current. In January 1808 he, together with another member of the Academy of Sciences at Munich, the well known chemist Gehlen, made a communication to that Academy in reference to the brilliant galvano-chemical discoveries of Humphry Davy at the laboratory of the Royal Institution in London.

"It appears to me quite certain that an event in connection with the war against France, brought on by Austria in 1809, gave rise to the first galvano-electric telegraph.

"The Austrian troops had, on the 9th of April 1809, begun to cross the river Inn, and so entered Bavaria quite unexpectedly. King Maximilian had hardly been informed of this, when he, on the 11th, with his family, in all haste, retired from Munich to the western frontier of his kingdom, to the town of Dillingen. He took with him Baron (soon afterwards created Count) Maximilian Joseph von Montgelas, who was then at the head of two important branches of administration in Bavaria—the Foreign and the Home Departments.

"By means of the line of Chappe's *optico-mechanical* telegraphs, which had been established for some time between the French frontier and Paris, the Emperor Napoleon I. got information of this sudden aggressive movement of the Austrian troops much sooner than it was thought possible by the leaders of the Austrian army, and he, without the least delay, started from Paris for Bavaria, on his way to his army. He came so unexpectedly to Dillingen, that he found King Maximilian in bed.

"There is no doubt, that by the speedy arrival of the Emperor Napoleon I. in the midst of his army, Bavaria owed its delivery from the Austrians. Munich had been already, on the 16th of April, occupied by the Austrian General Jellachich, but he was in less than a week after obliged to withdraw, and King Maximilian, on the 25th, re-entered his capital.

"This event, so vitally important for Bavaria, must at Munich have caused special attention to be directed to the utility of telegraphs.

"The Minister Montgelas had been witness to the surprise caused by the Emperor's unexpected arrival at Dillingen. The Bavarian Academy of Sciences was in one of his departments of administration, and Dr. Soemmerring, as one of its most celebrated members, was from time to time invited to dine with him at Bogenhausen, near Munich, where he lived.

"This was the case on the 5th of July 1809, when the Minister expressed to Soemmerring the wish to get from the Academy of Sciences proposals for telegraphs, having, as I allow myself to suppose, in view no other but optical (mechanical) telegraphs with improvements.

"Soemmerring, referring to this dinner, noticed in his diary briefly: 'The Minister wishes to get from the Academy proposals for telegraphs.' (Der Minister wünscht von der Akademie Vorschläge zu Telegraphen zu bekommen.)

"He at once resolved to try whether the visible evolution of gases from the decomposition of water by the action of the galvanic current might not be applied to telegraphic purposes, and three days after this dinner, he noted in his journal: 'I could not rest till I realized the idea of making a telegraph by the evolution of gases.' (Nicht ruhen können, bis ich den Einfall mit dem Telegraphen durch gasentbindung realisirte.)

"On the 22d of July his apparatus was already so far advanced that it was fit to work. He wrote: 'At last the telegraph is finished;' also: 'The new little telegraph machine works well.'

"He, however, went on making still further improvements, and it was only on the 6th of August, that he considered the telegraph quite completed. He was much pleased with its performance, being able to work through 724 feet of wire. He noted that day: 'I tried the entirely finished apparatus, which completely answers my expectation. It works quick through wires having the length of twice 362 feet, so that the current passes along 724 feet.'

"Two days later, he could already telegraph through 1,000, and, on the 18th August, through as much as 2,000 feet of wire. Subsequently he telegraphed even through 10,000 feet.

"On the 29th of August he exhibited his telegraph in action before a meeting of the Academy of Sciences at Munich.

"Soemmerring noted, on the 5th September, in his diary that he wished to send his telegraph to the National Institute of France.

"An opportunity for doing this presented itself in the beginning of November. An old acquaintance and scientific correspondent of Soemmerring, Baron Jean Dominique Larrey, Chief Surgeon to the French Army, came, after the conclusion of the war, from the French headquarters in Austria to Munich on his return to Paris. He most willingly offered to take the telegraph with him.

"Soemmerring sent him soon after to Paris a description of it (Mémoire sur le Télégraphe), and wrote, that he flattered himself the Baron would find an opportunity to exhibit the telegraph before the Emperor Napoleon I. He did not, however, for a long time receive any account from Larrey, who at last wrote, that he had presented the telegraph in the beginning of 1810 to the Institute, but no resolution had been come to. Soemmerring received his instrument back on the

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12th June 1811, full eighteen months after having intrusted it to Larrey.*

"I have asked in Paris permission to examine the Journals of the meetings of the Institute, and have found that Baron Larrey presented the telegraph on the 5th December 1809.

"Under that date the following entry is made: 'M. Larrey, au nom du Docteur Soemmering, professeur à Munic, présente un télégraph à pile galvanique qui peut servir la nuit.' The Institute appointed Biot, Carnot, Charles and Monge, (who were all four present at the meeting,) to examine the apparatus, and to report upon it. Although I have carefully looked over all the journals for nearly two years following, I have found no report. Biot, the only surviving one of the four members appointed to examine the telegraph, and to whom I have spoken on the subject, cannot recollect the reason why no report was made.

"The cause why Soemmerring's contrivance received so little attention in Paris may have been that the optical telegraph lines, established by the Chappes, were considered to answer sufficiently well.

"In August 1810 Soemmerring succeeded in inventing a contrivance for sounding an alarum. He made the gas, rising in small bubbles from two of the wire points in the water, collect under a sort of inverted glass spoon at the end of a long lever, which, rising, made a second lever, in the opposite direction on the same axle, descend, so that a small leaden perforated ball, put on it, would slide off, and, falling through a funnel on an escapement, set clockwork in action.

"This telegraphic alarum arrangement gave Soemmerring much pleasure, which he expressed in his diary with some detail. He wrote on the 23rd August: 'If the principal part of the telegraph gave me no trouble and demanded no alteration, but was ready in a few days, this secondary object—the alarum—cost me a great deal of reflection and many useless trials with wheelwork, which was driven by the streams of gas in the water to set the clockwork going, till at last I hit upon this very simple arrangement.'

"Soemmerring's alarum has not become generally known, because it was not represented on the two plates which accompanied the description of his telegraph in the Mémoires (Denkschriften) of the Munich Academy. These plates were engraved before the alarum was invented.

"Soemmerring had wires carried round the whole house in which he lived. It was Leyden's house, opposite Max-Gate. They were first covered with a solution of India rubber, and then varnished. He liked to show the action of his telegraph through these wires.

"On the 25th of October (1810), the then newly-married Crown Princess of Bavaria, Princess Therese of Saxe Hildburghausen (Altenburg), aunt to Her Imperial Highness the Grand Duchess Constantine (Alexandra Josifowna) of Russia (who was lately in London), honoured Soemmerring with a visit to see the telegraph. She was accompanied by her mother, aunt to His Highness the Duke of Mecklenburg-Strelitz, who is married to Her Imperial Highness the Grand Duchess Catherina Michailowna, daughter to the late Grand Duke Michailo Pawlowitch of Russia.—These were the first ladies who ever saw a galvanic telegraph in operation.

"On the 12th of April 1811, the Russian Minister, Prince Iwan Iwanowitch Bariatinsky, paid a visit to Soemmerring, whom he afterwards often invited to his house.

"In June, Soemmerring made some experiments to telegraph through water, first across a canal on the river Isar, and afterwards along the river itself.

"At these experiments, Count Jaroslaw Potocki, then colonel of the Russian Engineer corps, one of the sons of Count Stanislas Felix Potocki, was present. He, at his request, obtained from Soemmerring an apparatus, which he, on the 1st of July, exhibited in action at Baden, near Vienna, before his Majesty the Emperor Francis I., the Empress, and the Archdukes Charles and John, who were all highly pleased with it. The Emperor expressed his wish to have a telegraphic line established between the capital Vienna and his country palace Laxenburg.

"On the 22nd of August (1811), Prince Leopold of Saxe Coburg, afterwards married to the late Princess Charlotte and now King of the Belgians, honoured Soemmerring, who had been presented to him by Prince Bariatinsky, with a visit to see the telegraph in action.

"On the 9th of October the Bavarian Minister at Paris, Anton de Cetto, came to Soemmerring for that purpose. He was accompanied by his son, who is now the Bavarian Minister in London, Baron August de Cetto, and who has told me that he well recollects this visit.

"On the 15th of November Soemmerring sent a newly made telegraph to his son William at Geneva, who was then travelling under the guidance of the late Karl Ritter of Berlin, and who is now a medical practitioner at Frankfort.

"The editors of the "Bibliothèque Britannique," August and Charles Pictet and M. Maurice, inserted a description in their journal, in which there are many errors, although Soemmerring had sent an account, drawn up by himself, along with the instrument. They printed — in January 1812 — that the telegraph had been invented a few months before, whereas the first had been made in 1809. Soemmerring had sent a drawing of the alarum, but it is not correctly given.

"On the 28th and 29th of November Soemmerring had visits from the late Baron Alexander von Humboldt.

"On the 1st of February, 1812, Prince Karl Theodor, the second son of King Maximilian I., honoured Soemmerring with a visit to see the telegraph. His elder brother, Ludwig Karl, the Crown Prince, had already done so on the 9th of December, 1809.

"On the 8th of May, 1815, Soemmerring had the honour of a visit from the then Empress of Russia, Elizabeth Alexejewna. Her Majesty was accompanied by the King and the Queen of Bavaria.

"In February 1816, Dr. Thomas Thomson published in the "Annals of Philosophy" that Dr. Redman Coxe, professor of chemistry at Philadelphia in the United States, had informed him that he contemplated galvanism as a probable means of establishing telegraphic communication, and nominally by the evolution of gases from water. Coxe promised to follow up the idea, but he added, that it would demand time.

"The Abbé Moigno of Paris, states in both editions of his "Traité de Télégraphie électrique," (1849 and 1852,) erroneously the year 1810, instead of 1816, for the announcement of Coxe's idea. Now, as some authors date Soemmerring's telegraph from the year 1811, the American Coxe, in consequence of the two errors, has been in several works held out as the first projector of a galvanic telegraph.

"Dr. Thomson did not know that Coxe came six years and a half too late with his idea. Soemmerring, at Munich, had in 1809 executed, what Coxe in Philadelphia, in 1816, hoped in time to do, although it appeared to him, as he expressed it, a fanciful speculation.

"On the 27th and 28th of April, 1816, Soemmerring had visits from the celebrated astronomer Gauss of Göttingen.

"On the 2nd and on the 12th of July (1816) the British Envoy and Minister Plenipotentiary at Munich, the Hon. Frederic James Lamb, youngest brother to Lady Palmerston, who subsequently became the third Viscount Melbourne, paid two visits to Soemmerring, in order that he might acquire a knowledge of the telegraph and see its action. (We have already mentioned that he was the first Englishman who ever saw a galvanic telegraph in operation.)

"Soon after the Congress at Aix-la-Chapelle, on the 7th December 1818, Count Capo d'Istria, and on the 22nd of the same month Prince Alexander Sergejewitch Menchikoff visited Soemmerring to see experiments with the telegraph.

"In 1819 there was a prospect of Soemmerring's telegraph being brought to London. Lionel Hervey, who was British Secretary of Legation at Munich, having expressed a wish to get a telegraph for England, Soemmerring sent him the complete apparatus on the 25th May, and added an instruction, in English, about the way of using it. He expressed the hope, that Sir Humphry Davy would receive the telegraph favourably—perhaps improve it—and further its application to use in Great Britain.

"About a year after that Soemmerring learned that Hervey had not sent the telegraph to England. It was returned to him with the strange remark, that he (Hervey) had not forwarded it, fearing difficulties at the Custom House.

"Lionel Charles Hervey, the second Englishman, who saw a galvanic telegraph in action, was the grandson of one of the sons of John Hervey, who, in 1714, was created Earl of Bristol. His elder brother, Felton, had, in 1801, adopted the name of Bathurst, in addition to that of Hervey. In "Dodd's Baronetage" it is erroneously stated, that Bathurst had adopted the name of Hervey. Lionel Hervey had been already, on the 3rd of June, 1817, introduced to Soemmerring by Count Arco, the brother-in-law of Count Montgelas. He died in 1843."

On a future occasion we shall show from Dr. Hamel's account, how Baron Schilling first became acquainted with Soemmerring's telegraphic contrivances, and then, from the same source, describe the very active part he took in the development of electric telegraphy.

* Dr. Hamel gives a short account about Dominique Larrey's travels, and of his meritorious doings in his profession. He mentions the monument erected to his memory in Paris, in 1850. It stands in the court of the former military hospital, now military medical school, of Val de Grace. His son, Baron Hippolite Larrey, is the Surgeon-in-Ordinary to the present Emperor Napoleon.

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HOW TO FORETELL THE WEATHER.

We insert the following interesting and valuable instructions and observations extracted from the "Barometer Manual," compiled by Rear Admiral Fitzroy, F.R.S., and published by the Board of Trade; with a view of directing the attention of our readers to the important subject of meteorological changes and phenomena, especially in their relation to electrical manifestations and disturbances. The advantages which have already resulted from the publications of the Meteorological Department of the Board of Trade, have called forth a grateful recognition on the part of thousands of our brave and intrepid sailors, as well as others interested in our maritime commerce. Many precious lives and valuable property have been saved, owing to the timely information of approaching storms transmitted to our various seaports. The manual is written in a clear, concise, and intelligible language, so that "all who read may understand."

1. Familiar as the practical use of weather-glasses is, at sea as well as on land, only those who have long watched their indications, and compared them carefully, are really able to conclude more than that the rising glass* usually foretells less wind or rain, a falling barometer more rain or wind, or both; a high one fine weather, and a low the contrary. But useful as these general conclusions are *in most cases*, they are *sometimes* erroneous, and then remarks may be rather hastily made, tending to discourage the inexperienced.

2. By attention to the following observations (the results of many years' practice and many persons' experience) any one not accustomed to use a barometer may do so without difficulty.

3. The barometer shows whether the air is getting lighter or heavier, or is remaining in the same state. The quicksilver falls as the air becomes lighter, rises as it becomes heavier, and remains at rest in the glass tube while the air is unchanged in weight. Air presses on everything within about forty miles of the world's surface, like a *much* lighter ocean, at the bottom of which we live—not feeling its weight, because our bodies are full of air,† but feeling its currents, the winds. Towards any place from which the air has been drawn by suction,‡ air presses with a force or weight of nearly fifteen pounds on a square inch of surface. Such a pressure holds the limpet to the rock, when, by contracting itself, the fish has made a place without air,§ under its shell. Another familiar instance is that of the fly which walks on the ceiling with feet that stick. The barometer tube, emptied of air, and filled with pure mercury, is turned down into a cup or cistern containing the same fluid, which, feeling the weight of air, is so pressed by it as to balance a column of about thirty inches (more or less) in the tube, where no air presses on the top of the column.

4. If a long pipe, closed at one end only, were emptied of air, filled with water, the open end kept in water and the pipe held upright, the water would rise in it more than thirty feet. In this way water barometers have been made. A proof of this effect is shown by any well with a sucking pump—up which, as is commonly known, the water will rise nearly thirty feet, by what is called suction, which is, in fact, the pressure of air towards an empty space.

5. The words on scales of barometers should not be so much regarded for weather indications as the rising or falling of the mercury; for, if it stand at *Changeable* (29·50), and then rise towards *Fair* (30·00), it presages a change of wind or weather, though not so great as if the mercury had risen higher; and, on the contrary, if the mercury stand above *fair* and then fall, it presages a change, though not to so great a degree as if it had stood lower: besides which, the direction, and force of wind, are not in any way noticed. It is not from the point at which the mercury may stand that we are alone to form a judgment of the state of the weather, but from its *rising* or *falling*, and from the movements of immediately preceding days as well as hours, keeping in mind effects of change of *direction*, and dryness or moisture, as well as alteration of force or strength of wind.

6. The barometer is said to be *falling*, when the mercury in the tube is sinking, at which time its upper surface is *sometimes* concave or hollow; or when the hand (see page 2) moves to the left. The barometer is *rising*, when the mercurial column is lengthening; its upper surface being convex or rounded: or when the hand moves to the right.

7. In this part of the world, towards the higher latitudes, the quicksilver ranges, or rises and falls, nearly three inches—namely, between about thirty inches and nine-tenths (30·9), and less than twenty-eight inches (28·0) on *extraordinary* occasions; but the usual range is from about thirty inches and a half (30·5), to about twenty-nine inches. Near the Line, or in equatorial places, the range is but a few tenths, except in storms, when it *sometimes* falls to twenty-seven inches.

8. The sliding-scale (vernier) divides the tenths into ten parts each, or hundredths of an inch. The number of divisions on the vernier exceeds that in an equal space of the fixed scale by one.

9. By a thermometer the *weight* of air is *not* shown. No air is within the tube. None can get in. But the bulb of the tube is full of mercury, which contracts by cold, and swells by heat—according to which effect the thread of metal in the small tube is drawn down or pushed up so many degrees: and thus shows the temperature.*

10. If a thermometer have a piece of linen or muslin tied loosely round the bulb, wetted enough to keep it *damp* by a strip or thread dipping into a cup of water, it will show less heat than a dry one, in proportion to the dryness of the air, and quickness of drying.† In very damp weather, with or *before* rain, fog, or dew, two such thermometers will be nearly alike.‡

11. For ascertaining the dryness or moisture of air, the readiest and surest method is the comparison of two verified thermometers; one dry, the other *just* moistened and *kept so*. Cooled by evaporation as much as the state of the air admits—the moist (or wet) bulb thermometer shows a temperature nearly equal to that of the other one when the atmosphere is extremely damp or moist; but lower at other times, —in proportion to the dryness of air, and consequent evaporation—as far as twelve or fifteen degrees in this climate; twenty or even more elsewhere. From three to eight degrees of difference is usual in England; and about seven is considered healthy for inhabited rooms. The thermometers should be near each other, but not *within* three inches.

12. The thermometer fixed or attached to a barometer, intended to be used only as a weather-glass, shows the temperature of air about it nearly—but does not show the temperature of mercury within exactly. It does so, however, near enough for ordinary practical purposes—provided that no sun, nor fire, nor lamp heat is allowed to act on the instrument partially.

13. The mercury in the cistern and tube being affected by cold or heat, makes it advisable to consider this when endeavouring to foretell coming weather by the length of the column, and indispensable when making comparisons with other instruments.

14. Briefly, the barometer shows weight or pressure of the air; the thermometer—heat and cold, or temperature; and the wet thermometer, compared with a dry one, the degree of moisture and dampness.§

15. It should always be remembered that the state of the air *foretells coming* weather, rather than shows the weather that is *present*—(an invaluable fact too often overlooked)—that the longer the time between the signs and the change foretold by them, the longer such altered weather will last; and, on the contrary, the less the time between a warning and a change, the shorter will be the continuance of such foretold weather.

16. To know the state of the air, not only barometers and thermometers should be watched, but the appearances of the sky should be vigilantly noticed.

17. If the barometer has been about its ordinary height, say near thirty inches, at the sea level,‖ and is steady, or rising—while the thermometer falls, and dampness becomes less—North-westerly, Northerly, or North-easterly wind—or less wind—less rain or snow—may be expected.

18. On the contrary—if a fall takes place, with a rising thermometer and increased dampness, wind and rain may be expected from the South-eastward, Southward, or South-westward.

19. A fall, with low thermometer, foretells snow.

20. Exceptions to these rules occur when a Northerly wind, with wet (rain, hail, or snow), is impending, before which the barometer often rises (on account of the direction of the coming wind alone), and deceives persons who, from that sign only (the rising,) except fair weather.

21. When the barometer is rather below its ordinary height, say

* Glass, barometer, column, mercury, quicksilver, or hand.
† Or atmosphere, or the atmospheric fluid which we breathe.
‡ Or exhaustion.
§ A vacuum.

* Thirty-two degrees is the point at which water begins to freeze or ice to thaw.
† Evaporation.
‡ Twice their difference, subtracted from the higher, gives the dew point (nearly).
§ The two thus combined making a (Mason) hygrometer; for which, however, some kinds of hair, grass, or seaweed may be a substitute, though very inferior.
‖ It differs, or stands lower, about a tenth of an inch for each hundred feet of height directly upwards, or vertically, above the sea; its *average* height being 29·95 inches at the mean sea level in England: which height may be called "par" for that level. Allowances must, therefore, be made for barometers on high land or in buildings; each different elevation having its own (normal) line of pressure, or par height.

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down to near twenty-nine inches and a half (at the sea level), a rise foretells less wind, or a change in its direction towards the Northward, —or less wet; but when it has been very low, about twenty-nine inches—the first rising usually precedes, or indicates, strong wind—at times heavy squalls—from the North-westward—Northward—or North-eastward—*after* which violence a gradually rising glass foretells improving weather—if the thermometer falls. But, if the warmth continue, probably the wind will back (shift against the sun's course), and more Southerly, or South-westerly wind will follow: especially if the barometer rise is sudden.

22. The most dangerous shifts of wind, or the *heaviest* Northerly gales, happen *soon* after the barometer *first* rises from a very low point: or, if the wind veers *gradually*, at some time afterwards.

23. Indications of approaching change of weather, and the direction and force of winds, are shown less by the height of the barometer, than by its falling or rising. Nevertheless, a height of more than thirty (30·0) inches (at the level of the sea) is indicative of fine weather and *moderate* winds; *except* from East to North *occasionally*.

24. A rapid rise of the barometer indicates unsettled weather. A slow movement the contrary; as likewise a *steady* barometer, which, when continued, and with dryness, foretells very fine weather.

25. A rapid and considerable fall, is a sign of stormy weather, and rain (or snow). Alternate rising and sinking indicates unsettled and threatening weather.

26. The greatest depressions of the barometer are with gales from SE., S., or SW.; the greatest elevations, with wind from NW., N., or NE., or with calm.

27. Though the barometer generally falls with a Southerly, and rises with a Northerly wind, the contrary sometimes occurs; in which cases, the Southerly wind is usually dry with fine weather, or the Northerly wind is violent and accompanied by rain, snow, or hail; perhaps with lightning.

28. When the barometer sinks considerably, much wind, rain (perhaps, with hail), or snow will follow; with or without lightning. The wind will be from the Northward, if the thermometer is low (for the season)—from the Southward, if the thermometer is high. Occasionally a low glass is followed or attended by lightning *only*; while a storm is beyond the horizon.

29. A sudden fall of the barometer, with a Westerly wind, is sometimes followed by a violent storm from NW., or North, or NE.

30. If a gale sets in from the E. or SE., and the wind veers by the South, the barometer will continue falling until the wind is near a marked change, when a lull *may* occur; after which, the gale will soon be renewed, perhaps suddenly and violently, and the veering of the wind towards the NW., North, or NE. will be indicated by a rising of the barometer with a fall of the thermometer.

31. Three causes (at least)* appear to affect a barometer:—

32. *First.* The direction of the wind—the North-east wind tending to raise it most—the South-west to lower it the most, and wind from points of the compass between them proportionally as they are nearer one or the other extreme point.

33. N.E. and S.W. may therefore be called the wind's *poles*.

34. The range, or difference of height shown, due to changes of direction *only*, from one of these bearings to the other (supposing strength or force, and moisture, to remain the same), amounts in these latitudes to about half an inch (as read off).

35. *Second.* The amount—taken by itself—of vapour, moisture, wet, rain, or snow, in the wind, or current of air (direction and strength remaining the same), seems to cause a change amounting in an extreme case to about half an inch.

36. *Third.* The strength or force alone of wind, from any quarter (moisture and direction being unchanged), is preceded, or foretold, by a fall or rise, according as the strength will be greater or less, ranging in an extreme case to more than two inches.

37. Hence, supposing the three causes to act together—in extreme cases—the height would vary from near thirty-one inches (30·90) to about twenty-seven inches, (27 00), which has happened, though rarely; (and even in *tropical* latitudes).

38. In general, the three causes act much less strongly, and are less in accord; so that ordinary varieties of weather occur much more frequently than extreme changes.

39. Another general rule requires attention; which is, that the wind usually *appears* to veer, shift, or go round *with the sun* (right-handed, or from left to right),† and that when it does not do so, or backs, more wind or bad weather may be expected instead of improvement.

40. It is not by any means intended to discourage attention to what is usually called "weather wisdom." On the contrary, every prudent person will combine observation of the elements with such indications as he may obtain from instruments: and will find that the more accurately the two sources of foreknowledge are compared and combined, the more satisfactory their results will prove.

41. A barometer begins to rise considerably before the conclusion of a gale, sometimes even at its commencement. Although it falls lowest before high winds, it frequently sinks very much before heavy rain. The barometer falls, but *not always*, on the approach of thunder and lightning.* Before and during the *earlier* part of settled weather it usually stands high, and is stationary; the air being dry.

42. Instances of fine weather, with a low glass, occur, however rarely, but they are always preludes to a duration of wind or rain, *if not both*.

43. After very warm and calm weather, a squall or storm, with rain, may follow; likewise at any time when the atmosphere is *heated* much above the *usual* temperature of the season; and when there is or recently has been much electric or magnetic disturbance in the atmosphere.

44. Allowance should *invariably* be made for the previous state of the glasses during *some days, as well as some hours*, because their indications *may* be affected by distant causes, or by changes close at hand. Some of these changes may occur at a greater or less distance, influencing neighbouring regions, but not visible to each observer whose barometer feels their effect.

45. There may be heavy rains or violent winds beyond the horizon, and the view of an observer, by which his instruments may be affected considerably, though no particular change of weather occcurs in his immediate locality.

46. It may be repeated that the longer a change of wind or weather is foretold before it takes place, the longer the presaged weather will last: and, conversely, the shorter the warning, the less time whatever causes the warning, whether wind or a fall of rain or snow, will continue.

47. Sometimes severe weather from the Southward, *not lasting long*, may cause no great fall, because followed by a *duration* of wind from the Northward: and at times the barometer may fall with Northerly winds and fine weather, apparently against these rules, because a *continuance* of Southerly wind is about to follow. By such changes as these one may be misled, and calamity may be the consequence; if not duly forewarned.

48. A few of the more marked signs of weather—useful alike to seaman, farmer, and gardener, are the following:

49. Whether clear or cloudy—a rosy sky at sunset presages fine weather:—a red sky in the morning bad weather, or much wind (perhaps rain):—a grey sky in the morning, fine weather:—a high dawn, wind:—a low dawn, fair weather.†

50. Soft-looking or delicate clouds foretell fine weather, with moderate or light breezes; hard-edged oily-looking clouds, wind. A dark, gloomy, blue sky, is windy; but a light, bright blue sky indicates fine weather. Generally, the *softer* clouds look, the less wind (but perhaps more rain) may be expected; and the harder, more "greasy," rolled, tufted, or ragged,—the stronger the coming wind will prove. Also—a bright yellow sky at sunset presages wind; a pale yellow, wet:—and thus by the prevalence of red, yellow, or grey tints, the coming weather may be foretold very nearly:—indeed, if aided by instruments, almost exactly.

51. Small, inky-looking clouds foretell rain:—light scud clouds driving across heavy masses show wind and rain; but if alone, may indicate wind only.

52. High upper clouds crossing the sun, moon, or stars, in a direction different from that of the lower clouds, or the wind then felt below—foretell a change of wind.‡

53. After fine clear weather, the first signs in the sky of a coming change, are usually light streaks, curls, wisps, or mottled patches of white distant cloud, which increase, and are followed by an overcasting of murky vapour that grows into cloudiness. This appearance, more or less oily, or watery, as wind or rain will prevail, is an infallible sign.

* Electrical effects are yet uncertain.

† With watch-hands in the northern hemisphere: but the *contrary in south latitude*. This, however, is only *apparent*; the wind is actually circulating in the *contrary* direction: as a circle, or circular figure, turned horizontally, while moved across a map, or hart, will explain better than words.

* Thunder clouds rising from *north-eastward*, against the wind, do not usually cause a fall of the barometer.

† A "high dawn" is when the first indications of daylight are seen above a bank of clouds. A "low dawn" is when the day breaks on or near the horizon, the first streaks of light being very low down.

‡ In the tropics, or regions of trade winds, there is generally an upper and counter current of air, with very light clouds, which is not an indication of any approaching change. In middle latitudes such upper currents are not so frequent (*or evident?*) except before a change of weather.

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54. Usually, the higher and more distant such clouds seem to be, the more gradual, but general, the coming change of weather will prove.

55. Light, delicate, quiet tints or colours, with soft undefined forms of clouds, indicate and accompany fine weather: but gaudy, or unusual hues, with hard, definitely outlined clouds, foretell rain, and probably strong wind.

56. Misty clouds forming, or hanging on heights, show wind and rain coming—if they remain, increase or descend. If they rise, or disperse—the weather will improve or become fine.

57. When sea birds fly out early, and far to seaward, moderate wind and fair weather may be expected. When they hang about the land, or over it, sometimes flying inland, expect a strong wind, with stormy weather. As many creatures besides birds are affected by the approach of rain or wind, such indications should not be slighted by an observer who wishes to foresee weather.

58. There are other signs of a coming change in the weather known less generally than may be desirable, and therefore worth notice; such as, when birds of long flight, rooks, swallows, or others, hang about home, and fly up and down or low—rain or wind may be expected. Also when animals seek sheltered places, instead of spreading over their usual range: when pigs carry straw to their sties; when smoke from chimneys does not ascend readily (or straight upwards during calm), an unfavourable change is probable.

59. Dew is an indication of fine weather; so is fog. Neither of these two formations occur under an overcast sky, or when there is much wind. One sees fog occasionally rolled away, as it were, by wind—but seldom or never *formed* while it is blowing.

60. Remarkable clearness of atmosphere near the horizon: distant objects, such as hills, unusually visible, or raised (by refraction)*—and what is called "a good *hearing* day," may be mentioned among signs of wet, if not wind, to be expected.

61. More than usual twinkling of the stars; indistinctness or apparent multiplication of the moon's horns; haloes: "wind-dogs,"†—and the rainbow; are more or less significant of increasing wind, if not approaching rain, with or without wind.

62. Near land, in sheltered harbours, in valleys, or over low ground there is usually a marked diminution of wind—during part of the night—and a dispersion of clouds. At such times an eye on an overlooking height may see an extended body of vapour below (rendered visible by the cooling of night) which *seems* to check the wind.

63. The dryness or dampness of the air, and its temperature (for the season), should *always* be considered—*with other* indications of change or continuance of wind and weather.

64. On land, generally, there is more difficulty in ascertaining the real direction of the wind, in practice, than there is at sea—where sails, or a vane and a compass, are always at hand, uninfluenced by heights, or eddy winds.

65. Some observers notice smoke, others clouds (seldom going with the *local* wind, *below*, though generally correct as respects the *prevailing* wind), some mark the vane, or weathercock, while only a few of the telegraph observers know how their points of reference bear by the world (or map), or by a magnetic needle, of which the variation is still less often known within a point of the compass (if indeed understood.)

66. Such persons should be advised to *mark* a true east and west line, *about the time of the equinox*, by the sun at rising or setting; and by it give their bearings, or directions of wind. And they should take its direction from that of the *lower* clouds (when they are not very distant), compared with that of vanes and smoke—in preference to any other indication.

67. Much more care is required in noticing the veering, shift, turn, or gyration of the wind, than has usually been thought necessary. Very rarely has the way the wind *went round* been noticed in ordinary registers.

68. These shiftings, or veerings of wind—being caused, generally, by the progression of cyclonic movements of the atmosphere which succeed or counteract each other, variously impinging against air at rest, or moving differently—require much attention.

69. With respect to the "normal" levels, lines, or barometric heights (namely, the *means*, above and below which instruments range, at places of various elevations), often, indeed generally, used on the Continent of Europe—it may be repeated that our word "par" may be a useful synonym, for ordinary use: thus—(say) twenty-four hundredths (or whatever it may be) above, or below par.

70. Wherever practicable, the vertical difference between any such level, and that of the ocean, should be ascertained, as each ten feet lowers the barometer about eleven thousandths of an inch. This sea level should be that of the ocean itself—at mean half tide—a level which should be the universal standard of reference.

71. "Weather glasses" were used even before the 18th century. Among others, De Foe watched and registered them in 1703 (see his account of "The Great Storm"): but it is an instance of the necessity for *repeating* information, that, generally speaking, even now so little real use is made of these instruments, however familiar, common, and inexpensive they have become.

72. Like seamanship, ability to foretell weather is acquired, by degrees, practically, and has not been hitherto attained by books; though it may now be so; in consequence of numerous recorded observations and opinions, brought together in late years, very carefully considered, and published at the lowest price by Government.

73. Instructions being thus available, based on scientific as well as practical conclusions, by such help properly studied, any one may become "weather-wise" who will notice, even once a day, the indications of the heavens, of thermometers, and of a barometrical instrument.

74. Marked distinction is advisable between such observations and instructions as are intended only for indicating changes of weather, or its duration, and those of a superior kind required for comparisons and elaborate deductions for scientific purposes.

75. To know whether a tube with mercury had been well boiled (as it is called) by holding and turning it over a charcoal fire, it is unnecessary to watch the tedious process. Subsequent examination of the metal in the glass tube, with a lens, and its "click" at the *top* of the tube, give unfailing evidences of the presence or absence of air, whether boiled or otherwise treated.

76. To verify the graduation thoroughly (not at a few casual heights *only*, by comparison with another barometer,) artificial pressure or exhaustion must be obtained by placing the instrument under the receiver of an air pump.

77. This is done at Kew Meteorological Observatory very completely; and it is *necessary* for accurate scientific barometers, though not for mere weather glasses.

78. While saying so much of the mercurial barometer, it would be an injustice to the Aneroid not to mention that ten years' experience of this small and *very* portable barometer—at sea, on land, and travelling, has induced its *high* recommendation (when *set properly*) as an excellent weather glass for small vessels or boats.

79. As all these barometric instruments often, if not usually, show what may be expected a day or even days in advance, rather than the weather of the present or next few hours, and as wind, or its *direction*, affects them much more than rain or snow, due allowance should always be made for days as well as for hours to come.

80. Annexed is a table of average temperatures between eight and nine o'clock A.M. near London, which may be used (with allowance for ordinary differences between Greenwich temperatures and others) to assist in foretelling the direction and nature of coming wind and weather.

81. The thermometer (shaded and in open air) when much *higher*, between eight and nine A.M., than the average, indicates southerly or westerly wind (tropical); but when considerably lower, the reverse or northerly (polar) currents of air.

82. These indications are not yet so generally familiar as they ought to become, being easily marked and very useful.,

83. The Aneroid, or a Sympiesometer, require a little *occasional* adjustment to a good mercurial barometer (as a standard) by turning the back screw of the former very gently and slightly, or by altering the pointer of the Sympiesometer.

84. By comparison with the Weather Report (meteorological), now published daily in the *Times*, *Shipping Gazette*, and other Newspapers, any one may ascertain the state of a barometer, aneroid, or sympiesometer; or his *elevation above the sea level;* provided that the comparison is made, between eight and nine in the morning, with two or three published observations, for the same time, at places *nearest* to him, on different sides.

85. These daily statements of the weather, and indications of verified, as well as reliable *standard* instruments, show to those who are interested—and who regularly compare the accurate simultaneous observations thus generally available—not only what were the general and various states of atmosphere over Great Britain, Ireland, and the west of Europe—from Copenhagen to Lisbon—the same, or the previous morning (according to the time of day, and the newspaper referred to); but by such comparisons enable a useful degree of foreknowledge of weather, during the coming day or two, or even few following days, to be attained by any observant and considerate person.

* Much refraction is a sign of easterly wind.

† Fragments or pieces (as it were) of rainbows (sometimes called "wind-galls") seen on detached clouds.

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86. Now that the exclusive patent for making Aneroid barometers has expired, it is to be hoped and expected that our opticians will produce trustworthy, and even yet more portable instruments, on the same principle mainly—but improved in manufacture, as well as in the principle itself.

87. One kind may be soon anticipated—exactly compensated for changes of temperature, accurately (not *equally*) graduated on the disc surface—and as superior to the common Aneroid as a chronometer is to a cheap watch; but this instrument must be comparatively expensive.

88. Another description (a modification of this admirable French instrument) may be considerably cheaper and *smaller* than the present popular one. It may be a "pocket weather glass" (so to speak), suitable for fishermen, pilots, or seafaring persons employed in boats, or small coasting vessels—without space to suspend, or means to provide, a mercurial barometer.

89. Every day the *Shipping Gazette* (if morning papers are not seen) will afford the means of verifying and correcting such a "Storm-warner," without taking it to any other place, or person, for comparison.

THE ELECTRICAL MACHINE.

The first apparatus that was constructed for the exhibition of electrical phenomena, to which the name of *electrical machine* was given, was the globe of sulphur used by Boyle and Otto Guericke, with which they discovered electric light. The substitution of glass for sulphur was made by Newton, the rubbers employed in both cases being the hand of the operator. That important part of the machine called the *prime conductor* was first introduced by Boze; it consisted of an iron tube suspended by silken strings; and the substitution of a cushion for applying friction in the place of the hand, was first made by Winkler. Various were the forms now given to the electrical machine, for descriptions of many of which the curious reader is referred to Priestly's compendious *History of Electricity*. 1769. Dr. Watson's machine consisted of four globes turned by the same multiplying wheel, the electricity being collected by one common conductor, and Dr. Priestly seems to have been the first electrician who employed a conductor supported by an insulating pillar. It was a hollow vessel of polished copper in the form of a pear. The insulating support was of baked wood, which was preferred to glass as being a better insulator and less brittle. The conductor received its "fire" by means of a long arched wire, or rod of very soft brass, easily bent into any shape, and raised higher or lower as the globe required, and it terminated in an open ring, in which were hung some sharp-pointed wires playing lightly on the globe when in motion. The rubber consisted of a hollow piece of copper filled with horse-hair, and covered with basil skin; on it was laid an amalgam made by rubbing together mercury and thin pieces of lead or tin-foil on the palm of the hand, and then mixing it into a paste with a little tallow. The electric was a glass globe with a single neck enclosed in a deep brass cap, mounted in a frame of baked wood, and turned by a large multiplying wheel. The battery employed by Priestley consisted of sixty-four flint green glass jars, each ten inches long and two inches and a half in diameter; the coated part of each was half a square foot; the whole battery contained thirty-two square feet.

The electrical machines now constructed are exceedingly elegant pieces of philosophical apparatus, though they differ in form and arrangement almost as widely as the somewhat clumsy machines of the older electricians. There are two kinds of electrical machines in general use, the cylindrical and the plate machine. The former consists of a hollow cylinder of glass, supported on brass bearings, which revolve in upright pieces of wood attached to a rectangular base; a cushion of leather stuffed with horse-hair, and fixed to a pillar of glass, furnished with a screw to regulate the degree of pressure on the cylinder; a cylinder of metal or wood covered with tin-foil, mounted on a glass stand, and terminated on one side by a series of points to draw the electricity from the glass, and on the other side by a brass ball. In order to keep the rubber and conductor warm and dry, Mr. Ronalds suggested in 1823 to support them on hollow glass tubes, underneath which small lamps are placed. A more uniform temperature may however be obtained by placing underneath the cylinder a plate of metal 6 inches square, and keeping it heated by an argand lamp. A flap of oiled silk is attached to the rubber to prevent the dissipation of the electricity from the surface of the cylinder before it reaches the points. On turning the cylinder, the friction of the cushion occasions the evolution of electricity, but the production is not sufficiently rapid or abundant without the aid of a more effective exciter, which experience has shown to be a metallic substance. The surface of the leather cushion is therefore smeared with certain amalgams of metals, which thus become the real rubbers The amalgam employed by Canton consisted of two parts of mercury and one of tin, with the addition of a little chalk. Singer proposed a compound of two parts by weight of zinc, and one of tin; and Pfister a mixture of two parts tin, three zinc, and four mercury, with which in a fluid state six parts by weight of mercury are mixed, and the whole shaken in an iron, or thick wooden box, until it cools. It is then reduced to a fine powder in a mortar, sifted through muslin, and mixed with lard in sufficient quantity to reduce it to the consistency of paste. This preparation should be spread cleanly over the surface of the cushion, up to the line formed by the junction of the silk flap with the cushion; but care should be taken that the amalgam should not be extended to the silk flap. It is necessary occasionally to wipe the cushion, flap, and cylinder, to cleanse them from the dust which the electricity evolved upon the cylinder always attracts in a greater or less quantity. It is found that from this cause a very rapid accumulation of dirt takes place on the cylinder, which appears in black spots and lines upon its surface. As this obstructs the action of the machine it should be constantly removed, which may be done by applying to the cylinder, as it evolves, a rag wetted with spirits of wine. The production of electricity is greatly promoted by applying to the cylinder with the hand a piece of soft leather, five or six inches square, covered with amalgam. This is in fact equivalent to giving a temporary enlargement to the cushion.

Peschel states (*Elements of Physics*, vol. iii. p. 32), that the most effectual method of using amalgam is to spread it pretty thickly on the cushion itself, and then to cover it with a piece of silk, so that the amalgam may not be in actual contact with the glass; a sufficient quantity will work through the silk when the glass presses against it. By this arrangement the inconvenience of smearing the glass is avoided. One important qualification of the rubber is, that the surface on which the amalgam is placed, should carry off as quickly and as completely as possible, the electricity excited. To effect this, a piece of copper, or tin-foil, the same size as the cushion, is laid immediately under the surface coated with amalgam. If, however, the cushion is stuffed with metal filings instead of with horse-hair, this arrangement is not necessary. If the surface of the amalgam be covered with finely powdered *mosaic gold*, increased effects are said to be produced; but attention must be paid to the purity of this substance, or it may be inert or even injurious. According to Masson (*Archives de l' Electricité*, Sept. 1845), mosaic gold (bisulphuret of tin) somtimes contains as much as fifty per cent. of sal ammoniac, the hygrometric and conductric properties of which completely destroys its electric action. Before employing it, therefore, it should be reduced to a powder, and washed on a filter until it no longer gives any indication of the presence of sal ammoniac; it should be then carefully dried and employed in powder upon heated paper. Masson thinks that the bisulphuret of tin does not undergo decomposition, but that it becomes electrized by simple friction.

The use of the oiled silk flap is to prevent the dissipation of the electricity evolved on the glass by contact with the air; it is thus retained on the cylinder till it encounters the points of the prime conductor, by which it is rapidly drawn off. It is usual to cover with a varnish of gum lac those parts of the glass beyond the ends of the rubber, with a view of preventing the escape of the electricity through the metallic caps at the extremities of the cylinder, and the inside of the flap is also sometimes coated with a resinous cement consisting of four parts of Venice turpentine, one part of resin, and one of bees' wax, boiled together for about two hours in an earthen pipkin over a slow fire.

When the cylindrical machine is arranged for the development of either positive or negative electricity, the conductor is placed with its length parallel to the cylinder, and the points project from its side. The *negative* conductor supports the rubber, and receives from it the negative electricity, not by induction, as is the case with the positive conductor, but by *communication*. If it be required to accumulate positive electricity, a chain must be carried from the negative conductor (which of cource is insulated) to the ground; if, on the other hand, negative electricity be required, then the conductor must be put in communication with the earth, and the rubber insulated.—*From Noad's Manual of Electricity.*

TELEGRAPHIC FAILURES.

In consequence of the great diversity of opinion contained in the evidence and appendix to the Government report as to the cause of the failure of various submarine cables, I have endeovoured by a series of experiments to ascertain how far the insulating properties of gutta percha, &c., are affected by the various treatments to which it had

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been generally subjected in the course of manufacture, sheathing, and submersion.

Gutta percha as imported varies as much in its insulating qualities as it does in the amount of its impurities.

Inferior gutta percha dries up rapidly, that is, its insulating sap or moisture becomes exhausted by exposure to light and air.

Superior or pure gutta percha preserves its insulating sap or oil much longer.

When gutta percha is exposed to light and air the surface becomes oxidized and a conductor of electricity, while the interior, as it becomes dry, sustains the electric charge for a considerable time; when the insulating sap or moisture is thus exhausted, the percha, when immersed, absorbs water with great avidity, and the insulation very rapidly diminishes.

I have experimented upon gutta percha which has been exposed to air and light for various periods, from one month to two years, with corroberative results.

In reading over the account of the treatment to which the following cables have been subjected and their gradual failure, the tests I have made are by no means uninstructive.

1. The Red Sea core which was kept at a high temperature and exposed to light and air.

2. The Atlantic cable also exposed for months to light and air.

3. The Mediterranean cable which was kept for years exposed to light and air at the East India Docks. Several pieces of this cable were tested for their insulating capacities in the early part of 1860. When immersed in water the core would not retain a static charge for an instant, although the cable tested tolerably well in its dry state at the docks. This cable has been lately immersed between England and France, but I believe that it has not fulfilled the anticipations of the company which went to the expense of laying it down.

I have also tested several portions of the Malta and Alexandria core, which have been kept in a wooden hut, and in that condition exposed to light and air, I found that the outer coating had absorbed the compound between it and the second coating, leaving a space between the two. Mr. Varley speaks of a similar defect as follows:—

"Added to that, leaving out the inductive question, it is very objectionable to have a porous medium between the layers of gutta percha, because, should the water penetrate through a hole in any part of the exterior covering, it will gradually run along this semi-conducting porous material, and very likely come across some fault in the inner coating, and thus allow the electricity to escape."

Upon testing the outer coating for insulation, the following were the results:—

	Loss of Insulation.
Dry test	5° in 7 min.
West test	50° in 2 or 3 secs.

The application of "the wet test" was as follows:—The point of a platina wire was dipped in water, and then applied to the surface of the material under test.

The second coating of the core retained its original colour, but had become very dry.

	Loss of Insulation.
Dry test	5° in 18 min.
Wet test	50° in 2 or 3 secs.

Here the insulating sap or moisture had been exhausted, and the material, when impregnated with water, became useless as an insulator.

The gutta percha of the Malta and Alexandria core appears to be of an inferior kind, and, upon examination, was found full of impurities. It evidently owes its moderate insulating capacity to the layers of Chatterton's compound. Should any fault discover itself in the Malta and Alexandria cable it would be owing to the absorption of the tar and resin by the gutta percha. As insulators, when subjected to the action of water, these gums soon become utterly valueless.

It is evident that as long as the insulating sap or moisture is retained in the material, it is imperviable to water, and when the material is once deprived of its sap or insulating moisture, it never can be restored, it becomes useless as an insulator. I also find that by the subjection of gutta percha cores to the action of air and water alternately, for a time the insulation is rapidly impaired. Heat contracts the material, and causes it to seperate from the impurities, thereby enlarging the path of the fluid to earth.

Electrician.

COLONIAL TELEGRAPHS.

Telegraphic communication is now established with all the principal cities and towns in the neighbouring Colonies of New South Wales and Victoria in connexion with lines throughout the settled districts of this Province. At the close of 1860, twenty-six stations, 529 miles of line, and 654½ miles of wire were opened. The Revenue of this Department is rapidly increasing, whilst the facilities and conveniences it creates are largely being availed of: the messages transmitted in 1860 were 71,368, against, in 1859, 64,688. The intercolonial wires being the quickest means by which the European and Indian intelligence can reach Melbourne and Sydney—the services of this line are largely placed in requisition.—*Statistical Register of South Australia for* 1860.

The Student.

VOLTAIC ELECTRICITY—*continued.*

Conductivity of Fluids.—The *rationale* of what takes place when the poles of a voltaic battery is immersed in a fluid, possesses the highest amount of interest, by reason of its importance in the applications of electricity. The fluid conductor with which we have to deal is in almost every case water, holding various substances in solution. In the case of metallic conductors we have little to guide us in accounting for the instantaneous propagation of electricity to an immense distance. We use the term "current of electricity" for the sake of convenience, without accepting the hypothesis which this term would imply. Reasoning from analogy we should prefer to assume that the particles of metal in the wire become *polarized, i. e.*, assume the condition which we observe in a bar-magnet when broken into a number of pieces, each of which is a perfect magnet in itself. It is not our present purpose to enter into a full consideration of this hypothesis, but it is necessary that we should refer to it in attempting to explain the phenomena of fluid conduction.

Exp. 1. Connect the elements of a battery of six cells for a tension current and immerse the extremities of the conducting wires into a tumbler of spring water.

Bubbles of a gas, *hydrogen*, will immediately be disengaged from the negative terminal. Oxygen is evolved at the positive terminal; but combines with the metal to form an oxide of copper.

2. Place the galvanometer near the tumbler, with the ends of the copper strip immersed in the mercury contact-cups, and the index at zero. Plunge the positive terminal into one of the cups, and connect with the other a short piece of wire leading into the water of the tumbler. The extremity of this wire is now of course the positive terminal of the battery. Place the negative terminal into the water. A very slight deviation of the needle may perhaps be perceived by making and breaking contact with one of the mercury cups.

3. From a sheet of copper cut two small plates about 2 in. by 3 in., so that they may conveniently rest in an upright position within the tumbler. Attach these to the terminal wires of the battery, and immerse them, at a short distance apart, in the water. The deflection of the galvanometer, placed in circuit as before, will now plainly indicate the passage of a current. Bubbles of hydrogen will be seen upon the plate connected with the zinc pole of the battery; and, if the experiment be continued for a sufficient length of time, oxide of copper will be produced from the plate connected with the copper pole.

4. Note the amount of deflection upon the galvanometer.* Add gradually to the water in the tumbler a small quantity of common salt. As the salt dissolves, the deflection upon the galvanometer will be increased, showing that the conductivity of the fluid has been improved.

5. Approach the plates of copper in the fluid as close to each other as possible, without contact. The deflection will be increased. This effect is more perceptible in pure water than in the salt solution.

Let us now proceed to consider the action which results in the decomposition of the water. The molecules of this fluid are compound, formed of oxygen and hydrogen in chemical union. From a vast number of experiments, we know that oxygen is analogous in its electrical nature to the metals—that it is what is termed an *electro-positive*, and that oxygen is analogous to the acids and other *electro-negative* bodies. To account for the propagation of the electric current through the fluid, we suppose that the molecules of fluid in contact with the plates and between them become polarised, or assume two opposite electrical conditions, in the same manner as the fragments of a bar-magnet assume two opposite magnetic conditions at each pole. The electro-positive or hydrogen portion of the molecule is turned towards the negative terminal of the battery; the electro-negative or oxygen portion towards the positive terminal. Thus the

* This instrument, if exposed to draught of air, should be placed under a glass shade. The galvanometer referred to is that described in a former lesson.

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positive terminal is in contact with oxygen; the negative terminal with hydrogen gases—not yet, however, in the gaseous form. Now, we have reason to believe that the constituents of all compounds are held together by reason of an "affinity," which is the result of the opposite electrical conditions of these constituents. It is easy, therefore, to imagine that a positively electrised electro-negative should lose its "affinity" for an electro-positive, and *vice-versa*. The negative oxygen appears to *absorb* positive electricity, and we know that it loses for the time being its affinity for the electro-positive hydrogen, and may appear as a *gas*, endowed with *latent heat;* though in the case of the copper terminal, or *electrode*, it enters into combination with the metal. Generally speaking, at the moment a gas is freed from combination, or is *nascent*, its affinities are greatly intensified. This is the case with the hydrogen, which remains of the molecule of water decomposed at the positive terminal of the battery. We must remember that a similar decomposing action simultaneously takes place at the negative terminal at which hydrogen is evolved. The *oxygen* of the molecule decomposed at this terminal, and the hydrogen of the molecule decomposed at the positive terminal, must obviously enter into combination as water, since they are not evolved. They do not, however, enter into combination with each other, but they decompose the molecules next in succession between them; and a series of decompositions and recompositions is established between every intervening and polarised molecule of water.

According to the theory of which we have given a brief *apercu*, the resistance of a fluid to what is expressed in the electric current, is the opposition it offers to the polarization of its particles. The effect of adding common salt or sulphuric acid to water would be to lessen this opposition by bringing the particles further asunder.

In certain cases water appears to conduct electricity without suffering *electrolysis* or electrical decomposition. The quantity of the current in proportion to the bulk of water operating as a conductor, must in these cases be very small. The fluid then approximates to a metallic conductor, in which we suppose the particles or atoms to become polarised without decomposition, transferring their electrical charges from one to the other as the extreme particles lose their electricity by "absorption" of opposite electricities generated in the battery. The polarization of the particles of the wire between the poles of the battery is an action as constant as the transfer and neutralization of electricity between these particles. Of the "forces" or "principles" generated by the combination of the opposite electricities we do not at the present moment propose to treat. In a subsequent number we shall see that the mass of the earth, when employed as a conductor does not necessarily act as an *electrolyte* or fluid submitted to electrical decomposition, but in most cases as a metallic conductor of infinite extent.

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 78.]

With respect to the number of words per minute transmittted through various submarine telegraphs in their submerged and working state, we collect the following particulars from the evidence:—

		Words per Minute.	
Varna and Balaklava	310 nauts	5	A. Varley.
Varna and Constantinople	150 nauts	15	Ditto.
Red Sea	480 nauts	12	Forde.
Ditto	730 nauts	5 or 6	Ditto.
Atlantic	2,500 miles	2½	Thomson, maximum.
Ditto	„	2	Ditto, verified by himself.
Ditto	„	1·1	C. F. Varley, by relay.

It seems to be generally admitted by experimentalists that the rapidity of succession of the signals is not affected by varying the number of elements of the battery.

The most important problem to solve in submarine telegraphy undoubtedly is, how the signals may be made to follow each other with the greatest rapidity; and this resolves itself into two questions, how far can the circumstances upon which inductive action depends be removed, and what are the best means to lead away or destroy the residual charge of the wire after the original current has ceased to act. In the course of this inquiry we have obtained some valuable information with regard to the former, but much remains to be done before the latter question can be fully answered. We would, however, draw attention to the remark made by Mr. Varley (Quest. 2909), that in the practical working of an underground or submarine line, the available speed for communication can only be taken at one-third of the attainable speed.

One of the most fatal things that can happen to a submarine cable is the occurrence of faults by which a conducting communication is established between the internal wire and the surrounding water; the smallest and almost imperceptible fissure is sufficient to effect this, and the utmost care should therefore be taken in the manufacture to avoid them. When gutta percha is the insulating substance, they most frequently from air-holes produced during the preparation of the material, and occasionally from badly centering the wire, by which it is brought into close proximity to the external surface of the covering, so that a slight abrasion may occasion it to protrude. Both these defects may be in a great measure avoided by covering the wire with successive coatings. The wire, originally properly centered, may also become displaced in consequence of the softening of the material when exposed to a high temperature. In wires covered with masticated india rubber these particular defects do not occur to such an extent, but on the other hand it is necessary that the joints of the spirally twisted slip should closely adhere, otherwise in every place of imperfect contact fault would be generated. The masticated india rubber when warmed a is softened, and will yield to constant pressure; in this way wires so covered have failed. Another cause of defective insulation is the presence of some foreign substance or impurity. Very efficient tests been been devised to ascertain the existence of faults in a covered wire during or after the process of manufacture, and we do not doubt that a cable may be delivered by a manufacturer entirely exempt from faults.

But faults may originate during the process of laying, and even after this operation, in consequence of previous or subsequent inquries. Such injuries are sometimes mechanical, as from abrasion or other causes, and sometimes electrical, as for instance at places where the wire is eccentric or where the insulating covering is less perfect than in other parts of the line, the electricity escaping at the weak place may gradually injure the insulating covering so as at last to create a serious fault; this effect will be more likely to occur in long submarine lines, where strong currents of electricity are employed. In lines which can be worked with very weak currents such injuries may sometimes be postponed for a long time. These faults are difficult to discover and repair; but certain testing operations founded on the laws of the voltaic current have enabled the place of a fault to be determined within certain limits, which can be the more accurately ascertained according as the insulation of the line is more perfect. Several of the modes of testing actually employed, are described in the evidence.

(*To be continued.*)

THE TELEGRAPH IN FRANCE.

We have under our eyes a very interesting pamphlet entitled—"*De l'Abaissement des Taxes Telegraphiques en France,*" (on the lowering of telegraphic charges in France,)—after the reading of which every one will ask himself, as we have done, how is it that the number of telegrams transmitted in France does not exceed 500,000. The answer is not difficult; it is because the average cost of a telegram is 8fr. 6c. Since 1850 it has developed itself, as the following figures, showing the progression in the number of messages sent and revenue, will sufficiently show:—

MESSAGES.

In 1851	9,014	In 1855	254,532
„ 1852	48,105	„ 1856	860,299
„ 1853	142,061	„ 1857	418,616
„ 1854	236,018	„ 1858	assumed at 500,000

RECEIPTS.

In 1851	76,000 fr.	In 1855	2,487,000 fr.
„ 1852	542,000 „	„ 1856	3,191,000 „
„ 1853	1,512,000 „	„ 1857	3,333,000 „
„ 1854	2,075,500 „	„ 1858	3,667,000 „

As may be seen, the increase is continuous, not only in the number of messages sent, but also in the amount of revenue. Is it not possible to give a greater impetus to this new means of communication, and thus further the increase of messages and revenue?

Is it not possible to apply to telegraphy the system of uniformity in price, introduced into our postal arrangements in 1848, a system which has so marvellously contributed to the expansion of commerce, and to rivet the bonds of friendship and affection which unite families? The first condition of such a reform is, that it should not be a burden to the national treasury, but rather that it should yield a revenue—which would be more and more remunerative every year. Now M. Marqfoy proves by calculations which seem completely unanswerable, that 15,000,000 of despatches yearly are sufficient to authorise a reduction from the present high charge to one franc. Let

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us ask ourselves if there is any possibility of transmitting such a number of messages. We are using now on our chief lines the American telegraph. The success of this system depends absolutely upon the habit and regularity of the motions of the telegraphist; in short, quickness of transmission cannot surpass quickness of hand. Mechanical motive power *must* be substituted for the hand of the *employé*. There is then a greater quickness of communication, and less chance of error, &c. With mechanical manipulation, a simple wire would carry, without interruption, 25 words every minute—that is to say, 18,000 words, or 900 messages, every twelve hours, or 328,000 yearly. M. Marqfoy proposes to apply the following tariff for a message of twenty words:—One franc for the same or contiguous departments; two francs for all the rest of France.

Law Intelligence.

COURT OF EXCHEQUER, DECEMBER 18TH.

WHEATSTONE AND OTHERS *v.* WILDE.—ELECTRIC TELEGRAPHS.

THE declaration stated that Charles Wheatstone and the Universal Private Telegraph Company, the plaintiffs, sued Henry Wilde, the defendant, for the infringement of a patent granted to the first-named plaintiff as the first and true inventor of certain improvements in electro-magnetic telegraphs, the use of which patent was enjoyed by the second-named plaintiffs under a licence from the patentee.

The defendant pleaded Not guilty, and several other pleas denying the novelty of the invention and the infringement.

Mr. Grove and Mr. Webster were counsel for the plaintiff; Mr. Bovill, Mr. Manisty, and Mr. Hindmarsh represented the defendant.

The plaintiffs in this action are Professor Charles Wheatstone, who resides at 8, Lower Mall, Hammersmith, and the Universal Private Telegraph Company, whose chief offices are at No. 8, Hanover-square. The defendant is a contractor for the erection of lightning conductors, residing at Manchester. The case presented on behalf of the plaintiffs was, that on the 2nd of June, 1858, a patent was granted to Mr. Wheatstone for the term of 14 years for his invention for "improvements in electro-magnetic telegraphs and apparatus used for transmitting signs or indications to distant places by means of electricity," and the specification pursuant to the conditions was filed on the 2d of December in the same year. On the 10th of October, 1860, a patent was granted enabling Mr. Wheatstone to use and vend his invention. By an indenture of the 7th of August, 1861, between Professor Wheatstone, of the one part, and the Universal Private Telegraph Company, of the other part, the former assigned to the latter his letters patent, subject to arrangements enabling him to manufacture and sell telegraphic instruments and apparatus constructed upon the principles of his inventions. In May, 1860, at a meeting of the British Association, in Oxford, the plaintiff, Mr. Wheatstone, explained to the defendant the construction and working of his inventions, generally known as "The Magneto-electric Alphabetical Letter Showing Telegraph," or "The Universal Telegraph," with which the defendant expressed himself much pleased. Subsequently, at the defendant's request, Mr. Wheatstone forwarded to him several instruments, and in the latter part of 1860 the defendant applied for the agency in Manchester and its neighbourhood. On the 4th of September, 1861, Mr. Nathaniel John Holmes, the acting engineer of the plaintiff's company, was at Manchester attending a meeting of the British Association, when he was shown, at the office of the Magnetic Telegraph Company, a photograph of one of the instruments manufactured by the defendant, called "The Globe Telegraph," and a printed circular, referring to it as "H. Wilde's Patent, 1861." On the following day Mr. Holmes called on the defendant, and complained that he had infringed Professor Wheatstone's patent, which the defendant denied, claiming the instruments manufactured by him as his own invention. In August, 1861, the defendant obtained letters patent for an invention for "Improvements in Electro-magnetic Telegraphs and Apparatus connected therewith." The plaintiffs then applied to the Court of Chancery for an injunction restraining the defendant from using his invention, and the injunction was subsequently continued by Vice Chancellor Wood on terms that the plaintiff should bring an action to try his right. The action was accordingly brought.

Scientific evidence was adduced in support of the plaintiff's case, and a large number of the instruments were produced in court, with a view of elucidating the explanations of the various witnesses.

The case came on the following day, but was ultimately adjourned to the 13th February. We shall publish a full report of the trial when concluded.

WREXHAM—*The Electric Telegraph.*—An interesting lecture on the above subject was delivered by E. Wheeler, Esq., C.E., in the Town Hall, Wrexham, on Monday evening last. With the aid of diagrams, and working models of telegraphs, Mr. Wheeler gave his audience a very clear and simple explanation of the principles of the telegraph; and by various experiments engaged attention throughout. Mr. Wheeler has before lectured in Wrexham on electricity, and is evidently "well up" in that science. The attendance was very good, in spite of a wet night, and dirty streets, for which latter this borough has of late become remarkable.

Correspondence.

THE VISION OF EZEKIEL AND ELECTRICITY.

To the Editor of THE ELECTRICIAN.

SIR,—Having noticed several paragraphs in your publication relative to the early foreshadowing of the nature and applications of electricity, will you allow me to call the attention of your readers to the following remarkable and interesting fact. In a very early edition of the English Bible (1599) in my possession, the "Vision of Ezekiel" is illustrated by a woodcut or engraving. It represents a number of figures and a machine, which the prophet describes in the following words:—

Chap. I.—"The similitude also of the beasts, and their appearance, was like burning coles of fire, and like the appearance of lampes: *for the fire* ran among the beasts, and the fire gave a glister, and out of the fire there went lightning. And the beasts ran and returned like unto lightning. Now, as I beheld the beast, beholde a wheele appeared upon the earth by the beasts. The fashion of the wheeles and their worke was like unto chrysolyte; and the foure had one form, and their work was as one wheele in *another* wheele. * * Whither their spirit led them they went * * for the spirit of the beasts was in the wheeles. * * As they went forth I heard the voice of their wings like the voice of great waters. * * And I saw as the appearance of *amber*, and as the similitude of fire round about within it to looke too."

To those acquainted with the action of a powerful electro-magnetic engine, the above description by the prophet must be considered as strikingly appropriate.

The "spirit of the beast," as above also described has all the characteristics of frictional electricity. Professor Daniell, in his "Introduction to Chemical Philosophy," states that the friction of glass and reservoir substances "was accompanied by a *rustling* or *crackling noise;* and when the experiment was made in a dark room by *flashes and sparks of light upon their surfaces.*"

Dr. Wall observed the light and sound produced by rubbing pieces of *amber* with wool, and compared the *light* and *sound* of the electric fluid so produced to *thunder* and *lightning*.

Does the word "amber" signify an "electric?"—Yours, &c.,

STRADA.

To the Editor of THE ELECTRICIAN.

SIR,—In your article upon the iron ore on the island of Mingan (paragraph entitled "Canadian Iron Ore," p. 84), you mention that iron is found in Nova Scotia; can you or any of your correspondents inform me from what part it is procured, and also of the locality where the magnetic iron ore in North America is found? AN ENGRAVER.

[We will endeavour to ascertain the localities.—E. E.]

To Correspondents.

S. F., Miles Platting.—We are sorry that we cannot furnish you with the information you require respecting the new scientific society.

PLYMOUTH.—Gutta percha, as imported, is variable in its quality. The best only should be employed for insulating purposes.

MEDICO.—The study of frictional electricity has been in abeyance for several years. Machines of extraordinary power have recently been constructed for Mr. Varley and others. Ebonite discs are advantageously substituted for glass. Ebonite is now extensively employed in the construction of telegraphic and philosophical instruments, and of its applicability for the purpose we can speak from experience.

P., Deep Sea.—We believe that most of our telegraph engineers and electricians are of opinion that cables of light specific gravity are the best adapted for *deep* sea telegraphy.

J. EVERETT.—The directors of the Electric and International Telegraph Company have kindly granted us permission to visit their extensive establishments, for the purpose of giving in our columns, we trust, a popular description of the "wonders of the wire." It will be our efforts to popularize a science which has conferred such benefits upon the world at large, and which still is considered as in its "infancy."

DR. HAMEL.—We are sorry that the mistake should have occurred. Our readers will find, on reference to page 57, second column, line 51, the word "I *find*," which should have been "I *found*," which makes a material difference, inasmuch as Dr. Hamel personally visited Hartford for the purpose of ascertaining a fact. The passage reads as follows:—"I *found* this original telegram preserved in the Museum of the Historical Society at Hartford, in Connecticut, and have not failed to take an exact copy of it."

P. W. R.—See article on Insulation in last number. We certainly agree with Admiral Fitzroy that the telegraphs of the future should have "*large* wires, and the *most perfect insulation possible*." Such evidently was the conclusion arrived at by the Government Experimental Committee.

*** In our table of specific gravities of various materials employed in the construction of submarine cables the following errors occurred—

Gutta percha	9·725 instead of ·9725.
India rubber	9·25 instead of ·925

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The Electrician.

VOL. I. No. 9.—JANUARY 3, 1862.

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ON THE CONDITIONS OF THE VOLTAIC CURRENT.

THE question whether a perfect and uninterrupted circuit is necessary for the production of the voltaic current, or, in other words, whether the polarisation of a continuous chain of particles between the sources of opposite electricities, is an indispensable condition of the current, does not appear to have yet met with a satisfactory elucidation. We can by no means receive the ingenious and instructive experiment of M. GUILLEMIN, in which a Leyden jar is alternately charged by a battery, and discharged through the galvanometer, as conclusive upon this point. The conclusions which have been based upon this experiment, albeit in strict accordance with a generally received theory of the voltaic couple, have not been verified by further researches; and moreover, the observed phenomena appear to be susceptible of an explanation different to that which has been attached to them.

In a voltaic couple or series insulated from the earth, the tensions of the opposite poles or terminals, when disconnected, become equal, and of contrary signs. Starting from this point, M. GAVARRET, an accepted authority on electrical matters both in this country and abroad, endeavours to show that a *voltaic* current may proceed from the battery independently of the phenomenon of polarisation—the battery circuit remaining incomplete. "If we place each pole of the battery in contact with a sphere of conducting material, insulated from the earth; experience proves that whatever may be the volume of the two spheres *of equal size*, each will assume an equilibrium of tension with the corresponding extremity of the electromotor, of which they now become the true polar surfaces. The electricity which constitutes the charge of each sphere, must necessarily be generated within the battery." So far the explanation of what takes place does not appear to be open to question. Our author now assumes that the flow of electricity necessary to operate on the static charge of the insulated conductor is equivalent to a voltaic current along the wire. "The transfer of electricity occurs with such rapidity that, with spheres of ordinary size, the charge appears to take place instantaneously; and the flow of electricity exerts no appreciable influence upon the most delicate instruments. Let us imagine the diameter of the spheres to be augmented; the quantity of electricity and the time necessary to effect the charge will be increased accordingly. We can conceive their volume to be of such extent that the passage of electricity from the battery to each of the spheres may occupy a finite period of time; then evidently the flow of electricity, though almost instantaneous, will have a perceptible influence upon the needle of a galvanometer traversed by the fluid." "These considerations, in strict accordance with the theory of the voltaic couple, lead us to the following conclusion:—When each pole of an insulated battery is placed in communication with an insulated conductor, the volume of which may be considered as infinite, as compared to that of the electromotor, a true *current* of positive electricity will be produced from the copper pole, and a negative current from the zinc pole, which will last until the complete exhaustion of the metal and fluid of the battery; the current will take place as though the circuit of the battery were closed by a continuous conductor uniting its poles."

In the experiment of M. GUILLEMIN, quoted by M. GAVARRET in support of this proposition, a Leyden jar of ordinary dimensions was employed. The insulated conducting surfaces were therefore of small extent; and, assuming that the polarisation of the diclectric between them was inactive in producing the effect upon the galvanometer, we might reasonably conclude that the same effect would be observed when the conducting surfaces are otherwise disposed. The experiment appears sufficient to verify or disprove the conclusions which have been advanced; which whether faulty or otherwise, possess the greatest interest in regard both to the theory of the voltaic couple and its practical application. Our own experience of this modification of M. GUILLEMIN'S experiment leads us to question the accuracy of these statements. The conducting surfaces being placed at some distance apart, and insulated from the earth, were alternately brought into contact with the poles of a battery, and with the wires attached to a galvanometer by means of an *accumulating discharger*. In no case, however, was any deviation of the needle observed.

When one pole of a voltaic battery is led to earth, the tension of this terminal speedily becomes *nil;* a static charge being communicated to the soil immediately surrounding the earth plate, and absorbed by the mass of the earth, and the tension of the insulated terminal becomes doubled. Thus, if the flow of electricity along a wire, in operating a static charge, be equivalent to a *voltaic* current; such a current would undoubtedly be produced by alternately and rapidly connecting the poles of a battery with earth plates at any distance apart. We have not, however, been enabled to produce a deflection of the galvanometer by these means; nor have we any reason to believe that the negative result of the experiment was due to any defect in the apparatus employed, or to the want of care in the arrangements.

To what action then are we to attribute the effect of a voltaic current, as distinguished from the flow of electricity along a wire in communicating a static charge? The experiment of M. GUILLEMIN, at least, establishes the fact that a succession of discharges from a Leyden condenser is in fact a true voltaic current. What points of similarity can we perceive between the elements of a voltaic couple charged with opposite electricities, and the coatings of a Leyden arrangement; and in what does the current between them differ from that between two oppositely charged conductors, between which intervenes no polarised dielectric or electrolytic conductor, or from the flow along a wire of electricity of either sign? Such are the questions which must arise if the accepted theory of voltaic conduction be negatived by experiment, and which we believe to be susceptible of a complete and satisfactory answer.

ATMOSPHERIC IMPURITIES.

IN a paper by Mr. ANGUS SMITH, communicated to the Royal Society in the year 1849, some curious and important data were given upon the degree of vitiation from organic sources in various samples of atmospheric air, obtained in London and other localities. Ten cubic inches of air, taken from the vicinity of the lake of Lucerne, in Switzerland, were, for instance, found to decompose one grain only of a standard solution of permanganate of potassa, by the combination of its oxidisable constituents with the oxygen of the salt, existing in the condition of ozone. Air taken from a field in the North of Italy decomposed 6 grains of the same solution; while air obtained in London, during the summer of 1853, decomposed 29 grains; and that from the immediate vicinity of the water of the Thames, 58 grains. A portion of the atmosphere of a *house* in London was

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found to decompose *sixty grains* of the solution, and the air obtained from a pig-stye was sufficiently rich in carbon, hydrogen, sulphur, and perhaps other oxidisable bodies to decompose 109 grains of the same.

But little is known of the nature of the various organic impurities almost universally present in the atmosphere; the investigation of which is a problem offering considerable difficulty, and which as yet has only partially been attempted. We know that an atmosphere highly charged with oxidisable matter, such as that of a stable, cowhouse, or even of a sewer, may be comparatively uninjurious; while that above the marshy districts in the jungles of India and Ceylon, and in some parts of America, though charged in far less degree with the products of putrifaction, produces upon the human system the effect of an active and malignant poison.

"We do not live, we die," was the answer of an inhabitant of the Pontine marshes to a traveller who inquired how it was possible to live in such a district. From our observation of the men who are obliged to pass a considerable portion of their time within the London sewers, we believe their case to be by no means equally desperate. Yet the amount of organic matter in the *malaria* of the Pontine marshes is small in comparison to that in the atmosphere of a sewer, or even of a stable. Dupuytren and Thénard first detected in the *malaria* a nitrogenous substance of a very putriscible nature which has been assumed to operate as a ferment to the blood when introduced into the human system by respiration. Moscati, of Milan, filled large glass vessels with ice, collecting the water condensed from the atmosphere of the marshes upon the exterior surfaces of the glass. This water in a few days became covered with a scum "exhaling a cadaverous odour." In water collected by the same means Brocchi detected the presence of albumen. It is easy to conceive that any matter susceptible of putrefaction, held in solution by air, and brought into contact with the blood by respiration, may produce an effect similar to that which is known to follow the introduction into the veinous system of minute quantites of various animal poisons or virus. The action of impure air upon the system would depend upon the nature of this putriscible matter, and the condition in which it exists in combination with the air.

However reasonable and in accordance with observed facts may be the hypothesis which accounts for the insidious and deadly action of effluvia from animal and vegetable compounds by tracing their effect to the introduction of a putrefactive ferment into the blood; the almost invariable presence of a gas, *sulphide of hydrogen*, in such effluvia, has been considered by many chemists sufficient to explain this peculiar action. Like carbonic oxide, sulphide of hydrogen acts upon the blood by abstracting a portion of its oxygen; and the liberated sulphur probably assists in effecting a morbid alteration of the vital fluid. But although sulphide of hydrogen must in every case act most prejudicially upon the animal system, its presence in small proportion in *malaria*, and in various miasmatic effluvia, is insufficient to account for their peculiar effect. Sulphide of hydrogen produced in the laboratory, though most injurious to the system, even in a highly diluted state, possesses in no degree the action peculiar to the atmosphere of salt water marshes upon the coast of Africa or of the exhalations from the deadly swamps of Ceylon. We believe that the mode in which the gas is produced in these *malaria* furnishes the explanation of this fact, and explains in great measure the peculiar action of certain miasmatic effluvia.

Sulphide of hydrogen, in salt-water marshes, and in various districts in which fever and ague prevail, is evolved by the action of decomposing vegetable matter upon sulphate salts contained in the water, the latter being thus reduced to the condition of sulphides, which subsequently become decomposed by carbonic acid also in the water, with the evolution of sulphide of hydrogen. In its nascent state, this gas possesses the power of combining with certain hydrocarbons; and, when evolved by the above re-actions, is found to possess a considerable quantity of oxidizable matter in addition to the constituents of the gas. Thus a portion of the decomposing vegetable matter is held in solution by sulphide of hydrogen when thus produced; and to the action of this deleterious compound of an organic and mineral poison the physiological action of certain *miasmata*, which has so long remained a mystery, appears to be due. The subject is one of great interest, both in a chemical and a physiological point of view; but most happily we are already in possession of disinfectants and atmospheric purifiers, such as those which have been noticed in our columns, the action of which is sufficient immediately to destroy any miasmatic compound. The question of the most efficient application of these purifiers in various manners is one of which the importance in a practical point of view is scarcely to be overrated. This will probably engage our attention in a future number.

PROGRESS OF TELEGRAPHIC ENTERPRISE.

ALMOST immediately following the scheme of the Telegraph to India Company, we hear of another project, at least equally important, which is now *sur le tapis*. We are enabled to give the following details respecting this enterprise, which affords a new indication of progress in submarine telegraphy. It is proposed to connect, by the telegraph wire, our possessions in the West Indies, and also the islands in the same district belonging to France, Spain, Denmark, Sweden, and Holland—with each other in the first instance, and ultimately with North, South, and Central America, and probably with Europe. Negociations are already in progress with the various Governments through whose territories the line to be constructed in the first instance will pass. Starting from Jamaica—which possession we believe is to be connected by a branch northward to the Island of Cuba—this line will pass through St. Domingo, Porto Rico, St. Croix, St. Cristophe, Antigua, Montserrat, Guadeloupe, Dominica, Martinque, St. Lucia, St. Vincent—with a branch eastward to Barbadoes,—Grenada, Tobago, and Trinidad. Many of the smaller islands will probably be connected with the main line, the extent of which will be about fifteen hundred lines. The longest submarine line in this route will be about one hundred and fifteen miles. A modification of this scheme is however probable, involving a separate English line from Montserrat to St. Lucia, which would be independant of foreign interference, and a French line from Guadeloupe to Martinique.

The expansiveness of the present scheme provides for the extension of the line in a north-westerly direction from St. Iago to Havanna, and thence to Vera Cruz; and, in a north-westerly direction from Trinidad along the sea coast to La Guayra, Maracaibo, Carerlas, Cartegena, Buen Ayre, St. Marta, and thence to Chagres on the Isthmus of Panama. From the point of view of the electrician and telegraph engineer, the latter extension will be considered the most important portion of the undertaking, owing to the length of submarine wire it may be found desirable to submerge. We shall look forward with interest to the details, which may shortly be forthcoming, respecting the survey of the proposed route and the nature of the sea bottom on which a submarine cable is to be deposited in these latitudes.

A *WAIL* FROM THE "*TIMES*."

WE insert the following short extract from an interesting and important article which appeared in the *Times* on the 30th ult.:—

"If we had to deal with any other than a Democracy we should have no doubt upon the matter. It would be impossible for any Monarch to deny a reparation which all the civilized world has declared to be just, for he would feel his personal honour tarnished by such a war. To a Democracy the same appeal cannot be made; passion may possibly have spoken before reason could be heard.

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It is a thousand times to be regretted that the two peoples could not speak to each other during all this time through the instantaneous medium of an electric wire."

The intense and perplexing anxiety which have been felt, not only in England but over Europe generally, as to the result of our demand for reparation for the flagrant insult offered to the British flag, has awakened a deep and universal feeling of regret that there does not exist a telegraphic communication between the English and American shores. The question naturally arises as to the cause to which we must attribute the absence of so essential a desideratum. Surely the cause of failure in 1858 ought by this time to be well understood. With our present knowledge and experience we would as soon submerge a *naked* or exposed wire as we would a core subjected to the extraordinary treatment t which the late Atlantic core was subjected. It is a matter of astonishment that a single signal could have ever been transmitted from end to end. The rapidly increasing confidence in the practicability of ocean telegraphy will have, it is to be feared, to contend against difficulties of a far more formidable kind than those of manufacture, insulation, and submersion—the blighting influence of *concessions*. Exclusive rights have been obtained which at the present moment operate most prejudicially upon the spirit of public enterprise. Projects, whose chances of realization have long sunk into the very depth of improbability, still cling with a desperate pertinacity to the objectionable *concessions* acquired by their promoters to the detriment of telegraphic progress.

It is stated that such immunities are essential as an encouragement for the investment of capital, in undertakings of the kind; but what we do find? A concession is granted to an individual or to a number of individuals, this concession or right is disposed of at a fabulous price to a company, which proceeds to the construction and laying down of a line with a starved capital, under the direction of the no longer responsible *concessionaires* and their *protegés*. Whether the cable succeeds or fails the concessionaires are on the safe side. We venture to assert that had a tithe of the money expended in the purchase of *concessions* been applied to investigation and experiment we should have had some thousands of miles of ocean telegraphs in successful operations at the present day. And, as long as those rights and immunities remain in possession of lingering and semi-defunct Companies, we may look in vain for telegraphic progress.

COLONIAL PROGRESS.

WE have from time to time inserted in our columns some interesting details illustrative of the progressive history of electro-telegraphy in our colonial possessions. The infant and flourishing colony of Victoria stands prominent in the list for the skill, industry, and inventive genius of its population. It is highly interesting to trace the rapid rise and progress of this important colony. In 1836 its population did not exceed 200 souls; in 1861 it had increased to 540,332! Its live stock in 1841 consisted of 732,283 sheep, 50,837 cattle, and 2,372 horses; increased in 1860 to 5,794,127 sheep, 683,534 cattle, and 69,288 horses. Its export of wool in 1837 amounted to 175,081 lbs., and in 1860 to 24,273,910 lbs., the respective values being £11,639 against £2,025,066. The export of gold since the year 1851 is calculated at the enormous amount of £103,940,176. The number of acres of land under cultivation in 1851 were 52,176; in 1861, 419,592 acres. The manufacturing industry also exhibits a vast improvement, there being no less than 417 mills and manufactories of various kinds in active operation. The number of patents in force on the 3rd September, 1861, was 328. The character of those inventions is of a highly practical kind, such as discoveries and improvements in metallurgy, agricultural implements, dyeing, colour-making, distilling, soap and candle making, cements, textile materials, machines for preparing fibrous substances, furnaces, stoves, ventilators, steam and gas engines, boilers, diving apparatuses, clocks, philosophical instruments, bridges, railroads, water-wheels, wind-mills, grinding mills, pottery, glass, bricks, domestic implements, painting, sculpture, engraving, paper, printing, firearms, medical instruments, &c.

Internal communication, in the mean time, has undergone almost incredible change. Eight years ago, but one stone bridge and a few wooden bridges existed in the colony, and not a mile of metallic road was to be found in Victoria outside the city of Melbourne; but since the year 1853, no less than £5,272,620 have been expended in works for facilitating internal communication.

The Victorian or Government railways to be constructed will involve a large expenditure. Mr. Hunt Archer, in his interesting Statistical Sketch of the colony, states:—"The total amount which it is proposed to raise by loan for railway purposes, is £8,000,000, of which £4,000,000 has been taken up at the commencement of 1861."

The provisions for securing an efficient supply of water for the capital are also upon a gigantic scale, the cost having exceeded £800,000.

The postal communication shows in a similar manner the rapid advancement of this young and interesting colony. In 1851 there were 44 post-offices; through these passed 504,425 letters and 456,741 newspapers. In 1860 the number of post-offices had increased to 311, and the letters transmitted amounted to 8,116,302, and the newspapers to 5,683,023, yielding a revenue of £120,472.

Mr. Hunt Archer gives the following account of the progress of the electric telegraph in the colony:—"The first line of electric telegraph commenced in Victoria was that from Melbourne to Williamstown in 1853. It was completed and opened on the 1st March, 1854, and was the first line laid in the Southern Hemisphere, the second instance being found in Chili, where a line was reported to have been subsequently opened between Copiabo and Coquimbo. There are now 1504 miles of telegraphic wire in use in Victoria; the apparatus employed is Morse's Electro-magnetic Telegraph. The total expenditure for the construction of telegraphs, including stations, instruments, &c., up to the end of 1860, amounted to £163,475."

In our "Colonial Telegraphic Intelligence," the completion of several additional lines has been announced; and the erection of several other important lines is in contemplation. Nor are our telegraphic compeers neglectful of the advantages to be gained by adopting the most perfect form of insulator, and the best material for the purpose. A series of well arranged experiments, conducted under the directions of the General Superintendent of Telegraphs in the colony, lately published in our columns, bears evidence of a desire to possess an efficient and permanent system. The submarine line between the colony and Tasmania has unfortunately failed; but it is not likely that such a desideratum will long remain in abeyance. The energy and enterprize manifested in the realization of so many vast and gratifying results in both colonies, must ultimately succeed in establishing a permanent means of telegraphic communication between their respective shores.

Heartily do we unite with Mr. McGowan, the able Superintendent of the Victorian telegraphs, in deploring the loss of the great sea lines which contemplated the junction of our shores with India, and ultimately with the shores of Australia itself; and with him we cherish the hope that much time will not elapse ere that desideratum is attained. The new and improved methods of constructing submarine cables, so as to fully adapt them to meet the various conditions to which all sea lines are, in a greater or less degree, invariably subjected, points out the probability of an early consummation of such a project.

The careful investigation of climatological and meteorological phenomena, is a subject of prominent importance in South Australia. We quote, from the "Essays,"* to which we are

* Catalogue of the Victorian Exhibition, 1861. With Prefatory Essays, &c.

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indebted for much valuable information, the following interesting and instructive account of an extensive series of electrical observations :—

"The hourly registrations of the atmospheric electricity, which have been carried on at the Flagstaff-hill Observatory, with Quetelet's electrometer, gives the following results, after three years continuation :—

Quarters.	Mean Tension.	Mean Number of Registrations.	
	Positive Electricity.	Negative Electricity.	No Electricity.
	Parts.		
Spring	3·12	159	186
Summer.....	2·64	242	248
Autumn	2·89	117	153
Winter	3·40	71	148
Year	3·01	589	735

"The positive tension, being the normal state of atmospheric electricity, assumes its smallest value in the months of February and November, and its highest in the months of June and September, the range in the monthly mean amounting to 1·37 parts of division of the electrometer above mentioned. The electric tension is chiefly negative during hot winds, when clouds of dust are floating in the air, and during heavy rains; in the latter cases the negative tension is frequently so great that vivid sparks may be obtained from the instrument.

"The collation of the observations on the positive atmospheric electricity gives the following results with regard to the means for the even hours throughout the year, showing a daily amplitude of 2 to 3 parts of a division, the turning points of the same being at 8 A.M., 3 P.M. :—

A.M.	Part.	P.M.	Part.
Midnight...	2·97	Noon	2·13
2 hr.	2·54	2 hr.	2·72
4 hr.	2·64	4 hr.	1·92
6 hr.	3·41	6 hr.	3·03
8 hr.	4·17	8 hr.	3·53
10 hr.	2·87	10 hr.	3·36

It is a subject of congratulation that in a colony so distinguished for its industrial energy, its scientific operations, and manufacturing and commercial enterprize, the intellectual, moral, and religious welfare of its inhabitants is watched over with commendable care and solicitude, the most earnest and well directed efforts being made to secure to the rising generation the blessing of a good education, and a large number of commodious edifices are provided for the celebration of public worship. Such is the colony of Victoria in 1861.

THE TELEGRAPH AND WARFARE.

Her Majesty's Government has determined to forward to Canada a staff of telegraphists, selected from amongst the most skilled men belonging to the establishment of Royal Engineers, to be employed in laying down several hundred miles of telegraphic wires. In a country having an extensive frontier to defend, a line of telegraphs will afford a ready means of directing and regulating the movements of troops. During the Indian and the Crimean wars, and at the battle of Solferino, the electric telegraph rendered important services, and we hope that our naval authorities will not lose sight of its applicability as a means of communication between ships of war. Light cables of low specific gravity might be specially constructed for the purpose, and wound up on reels so as to be easily paid out, and conveyed from ship to ship, or between ships and the land, as emergencies might require. India rubber, from its allowing of considerable stretching without destroying the insulation is well adapted for such a purpose, and from its tenacity and low specific gravity, would hardly require any additional strength, except perhaps a sheathing composed of hempen strands for its preservation in paying out.

INDIA RUBBER AS AN INSULATOR FOR SUBMARINE TELEGRAPH WIRES.

[From a Correspondent.]

The most serious disadvantage in the application of india rubber arises from the tendency which this substance possesses of splitting itself up under certain circumstances into compounds having an isomeric relation, and in which condition oxidation most easily and readily sets in.

The tendency of the more highly complex hydrocarbons to arrange themselves in this form is such, that mere mechanical means is sufficient to induce it. We may mention by way of illustration, a fact with which every one acquainted with the manufacture of india rubber is familiar, that during the process of mastication a peculiar odour is perceptible, becoming more so as the mastication is continued, the india rubber at the same time is rendered darker in colour, and if the mastication has been carried too far, it is reduced into a soft and sticky condition. This is due to the generation of a volatile oleo-resinous substance by the action of the oxygen of the atmosphere, and heat, the consequence of molecular disturbance.

We are well aware of the influence which disintegration has in facilitating chemical action and how prone, in vegetable substances especially, proximate principles when placed in contact with oxidized material, or material in which a decaying action has set in, are to receive an impulse in the same direction.

Heat is a most active agent, light and heat combined are even more so, and exposure to the atmosphere under such influences, causes the india rubber, unprotected, to become readily oxidized in time, leaving the wires quite bare.

From experiments recently conducted on the changes to which india rubber is susceptible, it was found that copper wires covered up with masticated rubber, in five days were coated with a greenish matter insoluble in alcohol, ether, or water, in a few days more, the black oxide of copper could readily be determined, adhering to the inner surface of the rubber, whilst the copper wire itself was strongly corroded.

By heating the wires so covered, this action was prevented, from the dissipation of the volatile oleo-resinous matter, but instead of decay being perceptible on the side next the wire, rapid oxidation took place on the exterior side. This is caused by the physical structure of the india rubber being altered, and a condition more favourable to the manifestation of chemical action induced.

Wires so covered were heated in the vapour of water having different tensions, in carbonic acid gas and atmospheric air, in air the effect was perceptible when the rubber reached a few degrees within that given as its point of fusion (248° F). Those heated in aqueous vapour and carbonic acid gas, even although the temperature was carried much higher, had undergone no very perceptible change. The lengths were removed and placed in bottles; in every instance, although exclusion from light was carefully attended to, a gradual transition, proceeding to almost complete liquefaction of the rubber, and ultimate decay, set in.

Pressure modifies these effects by influencing the molecular condition of the india rubber; being in a degree antagonistic to the repulsive action of heat.

Another circumstance connected with pure india rubber insulated wire is the tendency it possesses to absorb water, the extent of which is a point on which a difference of opinion exists. Taking the power of retention of water in bodies to be controlled in some degree by their absorbing power, the following order represents the value of these materials as non-absorbents :—

Hooper's Vulcanized Compound S. G. 1·42.
" Vulcanized India Rubber
Wray's Compound
Masticated India Rubber
India Rubber after being heated
India Rubber cold cured

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Specimens of each of equal dimensions (having an area of one hundred square inches) were placed in distilled water, and allowed to remain undisturbed for 250 hours; the weight of each was carefully ascertained to the ·05 of a grain; on removal they were pressed between folds of bibulous paper, and allowed to hang until they ceased to lose weight; they were weighed at intervals of ten minutes, and the loss in weight for each sample and for each separate weighing comported itself in a most satisfactory manner to the first weighing after removal from the water, the loss being inversely proportional as compared with the original weights.

In order to utilize the superior insulating properties of india-rubber, it appears indispensable to apply over it a protecting body, which of itself is incapable of affecting the india rubber, or of being changed by elevation of temperature. INSULATOR.

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 95.]

At the period of the commencement of our inquiry the insulating properties of the gutta percha then in use had been found to be such, that improvement was not deemed absolutely necessary. But we have shown above that the leakage of electricity through gutta percha, as then prepared, is very large, and that if a foreign conducting substance should have found its way into the gutta percha covering of a wire, or if an air bubble should occur in the covering and when immersed become filled with water, or if the conducting wires become eccentric, the electricity will leak out at these weak places, and when currents of any strength are used will gradually destroy the insulation at the spot; and the failure of the line will only be a question of time. We have, moreover, shown that perfectly pure gutta percha, prepared by means of new processes, is far superior as an insulator to that in use at the time when we commenced our inquiry; and we have also shown that other substances are vastly superior to ordinary gutta percha in insulating power and less liable to injury from heat. Sufficient time has not, however, yet elapsed to submit these new substances to the test of experience, and the past history of the submarine telegraph shows that the greatest precaution is necessary in employing any new material until its durability under all circumstances, as well as its electrical properties, have been ascertained. Amongst these substances we have mentioned india rubber, which formerly failed and has been again introduced, in consequence of attempts having been made to use it, so as to avoid the defects to which it was originally found liable. For instance, it is necessarily laid on in ribbons, and it is proposed to effect the union of the edges of the ribbon without the use of any injurious solvent. In one case it is proposed to place the surfaces of newly cut material in immediate juxtaposition, by which means they unite; in another case the ribbon wound spirally on to the wire is covered with vulcanized india rubber, and the whole is subjected to a high temperature and pressure to compel the union of the edges; in the third case the ribbon, after being wound spirally on the conducting wire, is passed through hot water; another suggestion is that the liquid milk as it comes from the tree should be brought over and be directly applied to the wire so as to solidify for the first time upon the wire, but this has never yet been tried. Caoutchouc is always much more free from impurity than gutta percha, its properties are therefore far more constant, and the little experience which has been obtained as to its durability shows that there is no ground for apprehension on that score. Of the other compounds experimented upon by us the one proposed by Mr. Wray possesses remarkable powers of insulation; but how far the absence of experience of the durability of these new materials may warrant the adoption of any of them in lieu of gutta percha is still a subject requiring great care and consideration. If, however, it should be thought unadvisable at once to adopt them, gutta percha is now a well-tried material, the newly introduced pure gutta percha has remarkable insulating properties, and the perfection with which copper wire can be coated with it renders it an effcient insulator under ordinary circumstances; and it is established beyond a doubt, that, although instances have occurred in which it has been damaged by marine organisms, and been found liable to decay under rare and peculiar local circumstances, this gum will last for many years when used in moderate temperatures, coated with Stockholm tar, protected from light and covered with water.

The general result of the experience thus gained is, that no material, however promising, can be relied on until it has stood the test of time; and second, that too much care cannot be given to the manipulation of the insulating covering of a conducting wire, which is composed of substances so delicate in texture, and employed in such a manner that if a single defect, however slight, escapes detection during the process, the whole result is vitiated, as is the case with a chain when a single link is faulty. Perfection will be most likely to be secured by carefully testing the core in defined lengths, in water of a specified temperature, and causing every particular of the results of the tests to be carefully noted for future reference in case of faults.

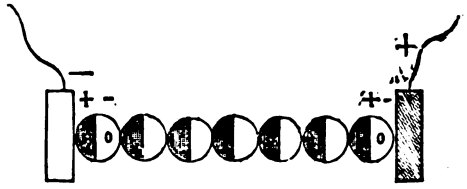
(To be continued.)

The Student.

VOLTAIC ELECTRICITY—*continued.*

Conductivity of Fluids—Earth Conductors.—When the metallic plates or *electrodes* attached to the battery terminals are very large in proportion to the zinc and copper plates of the voltaic couples, and when the volume of water, or water holding salts in solution, in which the terminal plates are immersed, is of corresponding extent, it becomes possible to transmit through the fluid a current of considerable quantity and of low tension. In this case the fluid is, to a great extent, analogous to a simple or metallic conductor; making up by its volume for its low degree of specific conductivity. To account for the effect of conduction, we assume that the molecules of fluid are polarised as before explained, but to a degree insufficient for the decomposition of the fluid.

A chain of such particles between the two electrodes is represented in the following diagram, in which we may endeavour to trace the the action which constitute a voltaic current, for the benefit of those who may be desirous of following out this point of theory.



The effect of polarization due to the attraction of opposite electricities by the electrodes must be considered as occurring simultaneously from each pole of the battery. This effect, it must be remembered, is due to the tension of the current; the resistance of a fluid, and probably also of a metal, to conduction being in fact the resistance it offers to the polarisation of its particles. In this instance the tension of the current being low, the molecules of water are incompletely polarised, and are not therefore decomposed. As it is necessary that we should analyze an effect which takes place simultaneously in two directions, we will consider in the first instance, the action which occurs at the positive electrode. Here negative electricity, or that which is peculiar to the element oxygen of the water, is neutralised by positive electricity, in the molecule of fluid in contact with the charged plate. This particle of fluid is therefore depolarised, and assumes a condition of positive tension. It however immediately absorbs negative electricity from the next polarised particle in the chain, its tension for the moment is restored to zero, and it again becomes polarised. The same action occurs in each particle consecutively, until we arrive at the molecule in contact with the negative plate. This molecule, if we conceive the negative electrode to have been inactive, would necessarily assume a positive tension. In this case its positive charge would be absorbed by the negative electrode, and its tension be reduced to zero. But if, on the theory of two electrical fluids, we conceive that an action similar to that which we have traced from the positive plate, but occasioning the transfer of electricity of the opposite sign in the contrary direction from particle to particle, is simultaneously produced by the negative electrode; thus, in the above diagram, each intervening molecule, with the exception of those in contact with the electrodes, may be regarded as transferring its positive electricity to the left, in the direction of the negative plate, and as receiving it from the right, *i. e.*, in the direction of the positive plate, and again, as transferring its negative electricity to the right, in the direction of the positive plate, and receiving it from the left in the direction of the negative plate. Thus, according to this view, a voltaic current, as distinguished from a flow of electricity of either sign along a wire, would be the transfer of the two electricities in opposite directions, from particle to particle in a polarised conductor.

If, while preserving the same sectional area of fluid, we double the distance between the plates, one half only of the quantity of electri-

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city transmitted in the first instance will pass through the water. The resistance to the polarising effect, *i. e.*, to the action which determines the conductivity of the liquid has therefore been doubled. If we now double the extent of our terminal plates, and the sectional area of the fluid between them, the same quantity of electricity as in the first instance will be conducted. Moreover, if the terminal plates be sufficiently large to transmit freely to the fluid the whole quantity of electricity generated in the battery, an increase of conductivity will be determined merely by increasing the sectional area of fluid. We thus perceive that resistance to conduction is dependent in great measure upon the *degree* of polarization which it is necessary for each molecule of the fluid conductor to assume; and that, in the case of a fluid conductor of infinite extent, the polarization of the molecules intervening between the terminal plates, and at some distance from them, might take place in an infinitely small degree, and their resistance to conduction be reduced accordingly.

In the earth we have a fluid conductor, which may be regarded as of infinite extent. Such is the conductivity of its mass that when due precautions have been taken to secure the perfect earth contact of the electrodes, and to prevent what is termed their *polarisation*, or the effect which is due principally to the presence of free oxygen upon the positive electrode, the earth appears to offer no resistance to the passage of a current. This is not the case, however, when the electrodes of the battery, which we may now term the *earth plates*, are in close proximity. In this instance all the intervening molecules of fluid become necessarily polarised to an appreciable extent, and their resistance to the passage of the current becomes perceptible in a corresponding degree. At whatever distance they may be placed apart, the portion of the earth operating as a conductor between them, must take somewhat the form of a spheroid, and is not merely, as occasionally has been presumed, "the effective section of the fluid held between them," Thus we conceive that the molecules in the vicinity of the earth plates, and by them polarised to an appreciable extent, each occasion the polarisation of two or more particles to a less degree; the *minimum* of polarisation, and the greatest number of polarised particles occurring midway between the earth plates.

The advantage of employing the earth for one half of the battery circuit may readily be perceived by the student in establishing telegraphic communication upon a small scale. Let us suppose that such communication is to be made between two buildings at a distance from each other of a hundred yards, more or less. The operator must first arrange his signalling instruments in each building. These may be simply two call-bells, worked by electro-magnets, or, if messages are to be transmitted, two vertical galvanometers or single-needle instruments. In either case a code of signals, or an alphabet, must be obtained or devised. Both the instruments *may* be constructed by the experimentalist upon the *data* we have given, and will continue to afford; but, if desirable, they may be purchased for a moderate sum. With regard to the battery arrangements, two or three small cells arranged for tension will be sufficient to work the needle instruments, even at a considerable distance; for the electro-magnets, if coiled with tolerably stout wire, a quantity current is necessary, as was fully explained in a former number. Supposing the operator to be ignorant of the fact that the earth may be employed for one half of the battery circuit; he would, in the case of the electro-magnetic call-bells, lead a wire from one pole of the battery through the first instrument, thence to the second instrument at the opposite station, placing both the magnets in circuit, and keeping the wire *insulated* from the earth, and thence back to the first station and to the opposite pole of the battery. On the other hand, using the earth as a conductor, he would connect one pole of the battery to earth by attaching to a metallic plate buried in the moist soil the wire leading from this pole. From the opposite pole he would then lead an *insulated* wire to the first instrument, and, having placed this in circuit, continue the wire to the opposite station, through the second instrument, and connect it with the earth by means of a second earth plate. He would thus not only save one half of the wire required in the first instance, but, by diminishing the total resistance of the circuit he would be enabled to reduce the amount of battery power necessary to work the instruments. The latter plan is that which is universally adopted in practice in preference to the wire circuit. The necessity for *insulating* the wire in both cases will be referred to in a subsequent number.

ON THE DURATION OF STOCKHOLM TAR AS AN INSULATOR.

A CORRESPONDENT requests the insertion of the following experiments upon the permanence of Stockholm tar as an insulator.

Messrs. Chatterton and Smith communicated the following information to the Committee on Telegraphs:—

"We wish we could feel equally confident that in the subsequent processes of manufacturing, and laying a cable, the core could be preserved from all injury; but knowing that cables have worked well for a time, and then without any apparent cause, failed, and knowing also that gutta percha itself undergoes no change whatever in seawater, we have endeavoured to ascertain how these failures have arisen, and from a series of experiments, we feel perfectly satisfied that accidental mechanical injuries in the core, where, by the insulation has been affected, have been temporarily repaired by the yarn serving being saturated with tar, and have stood the test and passed into the cable without detection.

"The result is obvious, for according to the nature of the injury, so it is a question of time only to the failure of the line.

"A length (4 yards) of core having the conductor exposed in four different places 'served' with hemp saturated with Stockholm tar and tallow, was immersed in water, and the insulation remained perfect for three days, the test being applied frequently from a sand battery of 504 pairs of plate 4×3½. It was then joined to a line of eight miles, the insulation of the whole when immersed using the same battery power. After 640 hours the last 172 without being charged. The defect is now offering so little resistance that the battery had to be reduced to 108 pairs to get the following reading.

Zinc to line.	Copper to line.
One minute, loss 75°	One minute loss 75°

"Five nails were forced through the gutta percha (passing through the strand conductor) in a length of core about 4 yards, which was 'served' with hemp saturated with tar and tallow. This was then immersed and remained perfect in insulation for 168 hours. the same battery power and instrument used as in the first experiment.

	Zinc to line.	Copper to line.
After 192 hours immersion	·8°	·5°
„ 216 „	2·	1·2
„ 240 „	3·3	2·
„ 288 „	10·	6·
„ 360 „	28·	23·5
„ 384 „	36·	30·5
„ 504 „	74·	30·

Reduced battery power to 108 Pairs.

	Zinc to line.	Copper to line.
After 528 hours immersion	30°	
„ 556 „	87	70°
„ 580 „	86	73
„ 652 „	90	72

"Each reading taken after one minute's electrification.

"This has now become quite bad, so much so, that were it to be charged with reversals for 24 hours from a strong battery, continuity would be destroyed."

Thus Messrs. Chatterton and Smith, by their tests, indisputably prove the inefficiency of Stockholm tar as a permanent insulator, which gives rise to an important question, how far the substitution of tar by absorption in place of the sap or moisture in the pores of gutta percha, bears upon the gradual failure of the Red Sea cables, as described by Mr. Siemens.

SUPPLEMENTARY REPORT* UPON THE ABSORBENT QUALITIES OF GUTTA PERCHA AND CAOUTCHOUC, AND OF THE EFFECT OF SUCH ABSORPTION ON THEIR INSULATING POWERS, BY WILLIAM ALLEN MILLER, M.D., F.R.S.

King's College, London, April 25, 1861.

THE following experiments were instituted with a view of testing still further the comparative tendency of gutta percha and caoutchouc to absorb moisture when these two bodies are submerged in water.

They show clearly that whether this submersion takes place under ordinary pressures or under very great pressures maintained for several weeks, there is a marked difference between the two substances. In both materials the amount of moisture absorbed is always less when they are immersed in sea water than when fresh water is employed.

The absorption of water by gutta percha is very slight, indeed almost *nil* in sea water. In fresh water it is appreciable, though trifling.

The absorption of water by caoutchouc after submersion is always sensible, the surface being usually rendered white and opaque, owing to the amount of water which has penetrated into the substance. This absorption, however, reaches only to a small depth, and does not

* Government Report, page 340.

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destroy or in anywise impair the insulating power of that portion of the caoutchouc which is beneath the moistened layer.

As might have been expected, the experiments prove clearly that the amount of the absorption is dependent upon the extent of surface exposed to the water. For example, in three samples of india rubber covered wire supplied to me by Mr. Rowland, which had each been submerged for an equal interval in sea water, the thickest coating had absorbed the least when equal weights of cross sections of the coatings were compared.

100 grains, No. 1, 1 inch in circumference, lost 11·1 on drying.
100 grains, No. 2, 1 1-16 inch in circumference, lost 9·7 on drying.
100 grains, No. 3, 1 5-16 inch in circumference, lost 7·4 on drying.

The materials employed in the experiments about to be described consisted of sheets of gutta percha and of caoutchouc of two different thicknesses, and of wires coated with both gutta percha and india rubber from various sources. Besides these, four bags of each material enclosing known weights of certain delinquescent salts, were sealed, and immersed in fresh water. The sheets and coated wires were each subjected to the action of both sea and fresh water in closed bottles exposed to the action of diffused light.

They were also exposed to the action of sea water for six weeks under a pressure maintained as steadily as was practicable by the hydraulic press, averaging about three tons upon the square inch, though occasionally during the night and on Sundays the pressure gradually declined to 0°.

Comparative trials of the insulating power of the coated wires were made before and after subjection to the above-mentioned experiments.

TABLE showing the ABSORPTION of WATER (in grains) by Gutta Percha and Caoutchouc.

Description of Specimen.	Under Pressure, Sea-water, 43 days.	Sea-water (bottle), 50 days.	Fresh Water (bottle), 50 days.	Absorption in Grains per Square Foot of Surface. Sea-water under Pressure.	Sea-water (bottle).	Fresh Water (bottle).
GUTTA PERCHA.						
Sheet 1/32 inch thick, 8×2 inch	1·5	0·4	2·4	5·7	1·8	10·8
Sheet 1/64 inch thick, 8×2 inch	—	0·0	0·6	—	0·0	2·7
Sheet 1/64 inch, West Ham Company, 8×2 inch	0·6	0·4	0·8	2·7	1·8	3·6
9 inches long. Coated wire, A 5,* 3/16 in. diam. (wire 1/16, gutta percha 1/16)	0·0	0·0	0·4	0·0	0·0	8·2
9 inches long. Coated wire, A 6,* 3/16 in. diam. (wire 1/16, gutta percha 1/16)	0·8	0·1	0·2	6·15	2·05	4·1
9 inches long. Coated wire, West Ham Company, 3/64 in. diam.	0·5	†0·4	†0·8	8·0	†6·4	†12·8
Sealed bags, Gutta Percha Company, 8 inches square, 1/32 inch thick. Carb. Potash	—	—	‡4·2	—	—	‡4·7
Carb. Potash	—	—	Spoiled.	—	—	Spoiled.
Chloride Calcium	—	—	‡4·5	—	—	‡5·0
Chloride Calcium	—	—	‡4·5	—	—	‡5·0
Mean	- -	- -	- -	4·51	2·01	7·1
CAOUTCHOUC.						
Sheet 1/32 inch thick, 8×2 inch } Silver and Co.	—	2·3	8·7	—	18·9	17·3
Sheet 1/64 inch thick, 8×2 inch } Silver and Co.	—	4·2	8·3	—	37·2	74·7
Slips, virgin, 8×2 inch (Hall and Wells)	3·9	2·1	5·9	17·5	9·45	26·5
Slips, manufactured, 8×2 inch (Hall and Wells)	3·8	2·1	4·5	17·1	9·45	20·2
Slips, manufactured, 8×2 inch (Silver)	7·0	—	—	31·5	—	—
9 inches long. Coated wire, virgin, 3/64 inch } Hall and Wells	1·0	†0·8	†1·5	16·0	†12·8	†24·0
9 inches long. Coated wire, manufactured, 3/64 inch } Hall and Wells	0·9	†0·5	†1·5	14·4	†8·0	†24·0
9 inches long. Coated wire, manufactured, 3/64 inch (Silver)	2·2	2·0	3·4	39·6	36·0	57·2
9 inches long. Coated wire, manufactured, 3/64 inch (Silver)	—	3·0	4·3	—	36·0	51·6
Bags from Silver and Co., 1/32 inch in thickness, 8 inches square. Carb. Potash	—	—	‡40·6	—	—	‡45·7
Carb. Potash	—	—	‡45·8	—	—	‡51·5
Chloride Calcium	—	—	‡47·9	—	—	‡53·9
Chloride Calcium	—	—	‡48·1	—	—	‡54·1
Mean	- -	- -	- -	22·7	21·0	41·7

The specimens of gutta percha (with the exception of those of the West Ham Company) were from the Gutta Percha Company, City Road. Those of caoutchouc from Messrs. Silver and Co., North Woolwich, and Messrs. Hall and Wells, Borough Road, Southwark. The wire in each case was 16 of copper gauge, or 1-16 inch thick.

In the foregoing table, the results which are given as the absorption per square foot are calculated from the actual experimental numbers contained in the first three columns of figures.

It will be seen that though the amount of absorption is liable to considerable variation in different specimens of the same substance, that the absorbent action of the caoutchouc is from 5 to 10 times as great as that of the gutta percha.

In determining the insulating powers of the coated wires after submersion, no difficulty is experienced in obtaining accurate results with the gutta percha, but the case is otherwise with the caoutchouc. The white film of caoutchouc which has absorbed moisture is not an insulator. It is therefore necessary to allow the cut surfaces of the wire which have been submerged to become dry by exposure to the air before proceeding to test the insulating power. If this were not attended to the most serious errors would arise.

In order to make these experiments, the coated wires after they had been completely submerged were bent into the form of a horse-shoe, and the middle portions were placed in a jar of water, so as to keep them completely moistened, whilst the ends were allowed to project into the air for some days. The white aspect of the projecting portions of the coating gradually disappeared as the caoutchouc became dry, and the insulating power was completely restored, although the body of the wire remained submerged during the whole time.

The electrical tests and their results are contained in the report of Mr. Rowland.

To the Chairman of the Commission on Electric Telegraphs.

WM. ALLEN MILLER.

Experiments made at Silvertown and at King's College on the 5th March, 17th, 19th, and 24th April, 1861, on the loss of insulation on short lengths of variously-coated copper wires, before and after being

* A 5 is a copper wire, 3-32 diameter, covered with two coatings of improved gutta percha, 3-32 thick, or 6-32 diameter.
A 6 is a copper wire, 3-32 diameter, covered with two alternate coatings, each of compound and improved gutta percha, 2-32 thick, or 6-32 diameter.
† Submerged 41 days. ‡ Submerged 46 days.

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subjected to a continuous pressure of three tons on the square inch in iron tubes filled with sea water, from the 5th March to the 17th April, 1861, a period of six weeks. Instrument employed, a Peltier electrometer.

Description of Wires.

No. 1. Gutta percha, A 5* (Gutta Percha Company).
2. Do. A 6* Do.
3. Do. West Ham Company.
4. Silver and Co. (masticated).
5. Hall and Wells (do.) No cotton next wire.
6. Hall and Wells (virgin unmasticated rubber). No cotton next wire.

The wires for insulation test, after they were removed from the hydraulic press, were bent in a horseshoe form, the middle portion being immersed in water whilst the ends were allowed to project into the air for rather more than an inch, and thus gradually became dry. (Each wire was similarly tested previously to its being subjected to pressure.)

The gutta percha coated wires speedily acquired their maximum insulating power, but the insulating power of the masticated india rubber increased from day to day as the moisture of the ends in air evaporated.

Result of Tests before and after being subjected to Pressure.

Loss of Insulation on Instrument 3° in one hour.
Full Tension 42°.

Before Pressure.	Loss of Insulation.	After Pressure.	Loss of Insulation.
	° ′ ″		° ′ ″
No. 1. - -	12 in 1. 38	- -	12 in 1. 17
No. 2. - -	12 in 2. 35	- -	12 in 2. 39
No. 3. - -	12 in 0. 58	- -	12 in 0. 43
No. 4.* - -	2·45 in 20. 50	- -	2·45 in 21. 0 4 in 87. 10
No. 5. - -	12 in 21. 50	- -	2·45 in 24. 20 4 in 80. 0
No. 6. - -	12 in 5. 20	The loss of insulation was too great to sustain full tension. This proved to be the case on its being subjected to test on several different occasions; viz., on the 17th, 18th, 19th, and 22d April, 1861.	

The above tests were not instituted to afford a comparison between the insulating powers of the various pieces of covered wires, as they differed in their lengths, from 7½ inches to 9 inches, and in the thickness of their coatings from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch, but to determine the effect of absorption upon the insulation of each material after having been immersed in sea water under pressure, as above described.

Owen Rowland.

Memorandum of Experiments on the effect of Absorption of Water by Gutta Percha and India Rubber.

Experiments upon the Action of Fresh and Sea Water upon the insulatory properties of Gutta Percha in sheets $\frac{1}{16}$ inch in thickness.

A sheet weighing 500 grains was put into an open glass bottle filled with fresh water, and exposed to air and light in the office on the 26th October, 1859. On the 17th November it was taken out and examined. Very shiny and much lighter in colour. It was dried between sheets of blotting-paper and towels and weighed. Increase in weight 10 grains. Tested for insulation for dynamic and static electricity with 512 elements. No loss.

Another sheet (500 grains) at the same time was put in a bottle filled with sea water and tested in the same manner as above. It was rather firmer and darker in colour. Increase in weight 5 grains, insulation good. Sheet again replaced in water. On the 8th February, 1860, this sheet was again examined. Appearance much the same. It was this time exposed in the office for 4 hours. Increase of weight 3 grains. Insulation good.

On the 4th August the sheet in fresh water was finally examined, dried between towels and sheets of blotting paper. In appearance very slimy; the slime being scraped off, no change observable in colour or texture. Dried between towels, &c.; increase in weight, 16 grains. Exposed to air for 2 hours, 13 grains. Insulation good.

Sheet in sea water examined: no change in texture—darker in colour—very slimy; slime scraped off. Increase in weight 8 grains; in half-an-hour 7 grains.

Experiments upon the Action of Fresh and Sea Water upon the insulating properties of Masticated India Rubber in sheet $\frac{1}{16}$ inches in thickness.

A sheet weighing 500 grains was put in an open glass bottle, filled with fresh water, and exposed to air and light in the office on the 1st Nov. 1859. On the 17th it was taken out and examined. Slimy and lighter in colour; dried between towels and sheets of blotting paper and weighed: increase in weight 29 grains; tested for insulation for dynamic and static electricity with 512 elements; no loss.

Another sheet (500 grains) was put at the same time in bottle filled with sea water, and treated as above described, Rather slimy to the touch; of a light brown colour; increase in weight 21 grains on 521 grains; insulation good.

On the 8th February, 1860, this sheet was again examined. It was very slimy; very much lighter in colour; no change in its elasticity. It was exposed for about 4 hours in the office; increase of weight 15 grains, or 515 grains; insulation good.

On the 4th August, 1860, the sheet in fresh water was finally examined, dried between towels and sheets of blotting-paper. Increased weight, 435 grains; colour very light and very slimy; no loss of insulation.

Sheet in sea water, &c. Increase in weight, 24½ grains; appearance much the same; very slimy; insulation no loss.

A large sheet of masticated rubber of the same thickness was put in a pan filled with fresh water, together with several india rubber bags containing acetate of potash, on the 18th October, 1859. It was taken out on the 3rd July, 1860, and examined. In colour it was rather whitish and slimy to the touch. The sheet was formed into a bag or bottle by drawing and tying its sides together, and filled with sea water, and the bottle part left in a basin containing sea water until the edges (out of the water) of the sheet were perfectly dry to avoid surface conduction. For electrical test it was placed upon a copper plate in connection with earth through instrument. The battery wire was then inserted in the water inside the bottle; the insulation was found to be perfect. It was afterwards tested in various ways with the same result. Having washed the sheet in clean fresh water and exposed it to the open air it regained it original colour; appeared perfectly clean and glossy. The result of these severe tests and the rapidity with which sheets of gutta percha and india rubber dry in open air seems to favour an impression that water does not permeate the substances but forms a slimy excrescence, more especially in the case of masticated india rubber, upon their surfaces. A great quantity of water adheres to the surface of the india rubber sheet in consequence of the furrows caused by the action of the cutting machine.

The acetate of potash put into the india rubber bags was found liquified, and had been so for some months. I attribute this to the imperfect sealing of the bags; the insulation of the bags was in each case perfect.

The surface of gutta percha becomes *darker* in water; of india rubber *lighter*.

Owen Rowland.

COAL MINES, AND THE TEMPERATURE OF THE EARTH'S CRUST.

BY DR. FAIRBAIRN, F.R.S.

It is now more than ten years since a series of experiments were commenced to determine the temperature at which certain substances become fluid under pressure. These experiments had reference to the density, point of fusion, and conducting power of the materials of which the earth's crust is composed, and were prosecuted with a view to the solution of some questions regarding the probable thickness of the earth's crust. Contemporaneously with these, we were fortunate in being able to ascertain by direct experiments, under very favourable circumstances, the increase of temperature in the earth's crust itself. These observations were obtained by means of thermometers placed in bore-holes at various depths, during the sinking of one of the deepest mines in England, namely, the coal mine belonging to F. D. Astley, Esq., at Dukinfield. The bore-holes were driven to such a depth as to be unaffected by the temperature of the shaft, and the thermometers were left in them for periods varying from half an hour to two hours. It is very difficult to arrive at accurate data on the subject of the increase of temperature in the earth's crust. The experiments hitherto

* The coating of this wire was violently stretched to the extent of about two inches in being pulled out of the pipe.

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made, give, unfortunately, somewhat conflicting results, and even in the same mine the rate of increase of temperature is by no means uniform. This is shown very clearly in the results obtained by Mr. Astley. It is scarcely probable, however, that the temperature in the mine shaft influenced the results, and we must, therefore, seek the cause of this irregularity in the varying conducting power of the different strata, arising from different density, and different degrees of moisture of the strata. As to the rate of increase, they appear to confirm previous experiments, in which it has been shown that the temperature increases directly as the depth. The rate is at first rather less than this, afterwards somewhat greater, and at last again less, but on the whole the straight line on which the temperature increases as the depths nearly expresses the mean of the experiments. The amount of increase indicated in these experiments is from 50° to 57¾°, as the depth increases from 5¾ yards to 231 yards, or an increase of 1° in 99 feet. But if we take the results which are more reliable, namely, those between the depths of 231 and 685 yards we have an increase of temperature from 57¾° to 70½°, or 17¾° Fahrenheit. That is a mean increase of 1° in 76·8 feet. This rate of increase is not widely different from that observed by other authorities. Walferden and Arago found an increase of 1° in 59 feet in the artesian well at Grenelle. At the salt works at Rehme, where an artesian well penetrates to a depth of 760 yards, or rather more than the Dunkinfield mine, the increase is 1° in 54·7 feet. MM. de la Rive and Marcet found an increase of 1° in 57 feet at Geneva. Other experiments have given an increase of 1° in 71 feet. In one respect the observations in the Dunkinfield mine are peculiarly interesting. As they give the temperature in various descriptions of rock, they appear to prove what has hitherto been partially suspected—namely, that the conducting powers of the rocks exercise a considerable influence on the temperature of the strata. If we add to this the influence of the percolation of water, we shall probably have a sufficient explanation of the irregularities observed in the experiments. From the above observations we have evidence of the existence in the earth of central heat, the temperature, so far as can be ascertained, increasing in the simple ratio of the depth. I do not, however, presume to offer an opinion as to whether this increase continues to infinitely greater depths than we have yet penetrated, as observations upon this point are still imperfect. But, assuming as an hypothesis, the law which prevails to a depth of 700 yards, continues to operate at still greater depths, we arrive at the conclusion that at a depth of less than two and a half miles the temperature of boiling water would be reached, and at a depth of 40 miles a temperature of 3000° Fahrenheit, which we may assume to be sufficient to melt the most refractory rocks of which the earth's crust is composed. If, therefore, no other circumstance modified the conditions of liquefaction, all within a thin crust of this thickness would be in a fluid state This, however, is not the case. At these depths the fusing point is modified by the pressure and conductivity of the rocks. We know that in volcanic districts, where the great subterranean laboratory of nature is partially opened for our inspection, the molten mass, relieved from pressure, pours forth from volcanic craters currents of lava which form a peculiar class of rocks. Besides this, it has been ascertained by Mr. Hopkins's experiments on soft substances, such as spermaceti, wax, and sulphur, that the temperature of fusion increases about 1·3 Fahrenheit for every 500lb. pressure per square inch, that is, in other words, that the temperature of fusion under pressure is increased in that ratio. If we assume this to be law for the materials of the earth's crust, and correct our previous calculations in accordance with it, we shall find that we shall have to go to a depth of 65 miles, instead of merely 40, before the point of fusion of the rocks is reached. It must, however, be observed that Mr. Hopkins's later experiments with tin and barytes, do not show such an increase of the point of fusion in consequence of pressure, and he is led to the belief that it is only in the more compressible substances that the law holds true. Independently of this, however, Mr. Hopkins points out to me that in the above calculation it is assumed that the conductivity of the rocks is the same at great depths as at the surface. In opposition to this he has shown experimentally that the conducting power for heat is at least twice as great for the dense igneous rocks as for the more superficial sedimentary formations of clay, sand, chalk, &c. And these close-grained igneous rocks are those which we believe must most resemble the rocks at great depths below the surface. Now, Mr. Hopkins shows that if the conductive power were doubled, the increase of depth, corresponding to a given increase of temperature, would be doubled, and we should probably have to descend 80 or 100 miles to reach a temperature of 3000°, besides the further increase which investigation may show to be due to the influence of pressure on the temperature of fusion. Mr. Hopkins, therefore, concludes that the extreme thinness of the crust assumed by some geologists to account for volcanic phenomena is untenable. Calculations on entirely independent data led him to conclude that the thickness did not fall short of 800, instead of 30 or 40 miles. If it be so much, he is further led to believe that the superficial temperature of the crust is due to some other cause than an internal fluid of nucleus. It remains a problem, therefore, which my friend Mr. Hopkins is endeavouring to solve, as to what is the actual condition of the earth at great depths, and the relation of terrestrial heat to volcanic phenomena.

ON THE AMOUNT OF THE DIRECT MAGNETIC EFFECT OF THE SUN OR MOON UPON INSTRUMENTS AT THE EARTH'S SURFACE.

THE Astronomer Royal during the late meeting of the British Association at Manchester, gave a *viva voce* account of some conclusions to which he had been led regarding the laws of the principal diurnal inequalities of terrestrial magnetic force, as deduced from ten years observations at Greenwich. He described in an admirable manner, and suited to the comprehension of all present, what was meant by deviation and diurnal inequalities. Taking, he said, a compass needle or other bar of magnetized iron, if this were freely suspended it would take up a definite position as affected by the earth's attraction. Two forces pulled the needle, one towards the north, the other towards the south. Its position, however, did not remain constant during the day, nor yet during the year; and it was of the utmost importance to register the deviations it made, either by the eye of an observer, or by the far more accurate method of self-registration. The latter method was employed at Greenwich, and was effected by causing a cylinder of sensitive paper to revolve once during the twenty-four hours; on this the beam of light reflected from the needle fell, and made a curved line on the sensitive paper. In a similar manner the amount of force pulling the needle north or south was registered; and thus the horizontal force acting on the needle endways, and that acting sideways were rendered visible, and their changes, from time to time, calculated. The common daily disturbing force varied in different years extremely, from 1848 to 1857; and monthly also, for in June and July it was greatest, and in December and January least. This last observation led him to consider that it might depend a good deal on the radiation of the sun's heat, which was greater in summer, of course, than in winter. An interesting diagram was exhibited showing the law of this disturbing force, and consequent deviation of the needle during the day. It was greatest at noon, and decreased from that time till eleven at night, when it was least. The disturbance at the time when greatest tended in a south-westerly direction. He was inclined to explain the fact of this direction being taken from the consideration that Greenwich was peculiarly situated with regard to the distribution of land and water on the face of the globe. During the early hours of the afternoon, the sun, when on the north of the equator, was vertical over a great space of water lying in a south-westerly direction from Greenwich, the radiation from which was very great. Magnetism and galvanism were in his view interchangeable terms: and it was well known that it was difficult to get a galvanic current through the earth at any place on its surface, when there was little or no moisture; and thus the sun shining before it reached the meridian of Greenwich, on the arid plains of Central Asia, would have less magnetic effect than a few hours later in our day.

SUPERIOR AND INFERIOR INSULATION.

THE following experiments were made to determine how far superior insulation, in portion of the length of a submarine cable, might influence another portion of its length possessing inferior insulation; as, for instance, in a cable where a portion is insulated with india rubber, and the remainder with gutta percha.

Two gutta percha covered wires of one mile in length each, and of precisely the same dimensions, were joined together, so as to form a cable of two miles in length; the whole being submerged in the water at a temperature of 56°. One end of the two miles being insulated, the other was placed in contact with the vertical stem of a Peltier electrometer. A static charge from 512 elements being imparted to the cable; the time the charge occupied in escaping therefrom through the coating into the water was taken, when the indicator of the Peltier electrometer fell to zero, in 1 minute and 36 seconds. One mile of the india rubber covered wire was now added to the above length, and also submerged in water, the passage into earth of the electric charge imparted into the lengthened cable, now occupied 2 minutes and 14 seconds. The experiment was several times repeated with the same result.

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Another gutta percha covered wire was submitted to a similar experiment. This wire was very faulty, only retaining the charge for 3 seconds. When the india rubber covered mile was added to its length, as in the first experiment, the charge leaked out in 3 seconds.

Another two miles of gutta percha covered wire were charged, and both together retained the charge for 58 seconds.

Upon charging one mile, which we will for distinction sake call A, it retained the charge for 1 minute and 35 seconds; while B, the other mile, only retained the charge for 45 seconds. From the first and third experiments, it appears that a superior insulator has a favourable influence upon an inferior one, when the latter is not excessively faulty.

Two miles of gutta percha covered wire of the same dimensions were now jointly charged, the indicator fell to zero in 1 minute and 45 seconds.

One of the above miles, when charged, lost its charge in 1 minute and 35 seconds.

Upon the second mile being charged, the charge escaped in 1 minute and 45 seconds, the same time occupied as on both miles together.

Three more cores were similarly subjected to experiment.

The first, a piece of the Malta and Alexandria core, 180 feet in legth. G. P. and Chatterton's compound.

The second, a piece of cable furnished by Mr. Thomas Allan, and constructed upon his principle by having the means of tensile strength inside the cable, and in contact with the copper conductor 180 feet long, *plain gutta percha* coating.

The third, a piece of special gutta percha (pure gutta) 330 feet in length.

The insulating capacities of the three pieces (all submerged in water at a temperature of 57°) were as follows:—

Malta and Alexandria core.

Loss of insulation	16° in 58 sec.	mean.
	16 „ 59 „	58·5
	16 „ 59 „	
	16 „ 58 „	

Allan's cable.

Loss of insulation	16° in 35 sec.	mean.
	16 „ 35 „	35·2
	16 „ 36 „	
	16 „ 35 „	
Special gutta percha	16° in 1 m. 20 „	mean.
	16 „ 1 m. 25 „	1·23·5
	16 „ 1 m. 25 „	
	16 „ 1 m. 25 „	
The three cores together	16° in 52 sec.	mean.
	16 „ 52 „	52·
Special gutta percha and Malta cores ...	16 „ 1 m. 10 „	mean.
	16 „ 1 m. 11 „	1·10·5
Allan's and Malta cores...	16 „ 45 „	mean.
	16 „ 45 „	45 sec.
Allan and special gutta percha cores ...	16 „ 54 „	mean.
	16 „ 55 „	54·5

It will be observed that thus, by combining the various materials, the charge is sustained for a longer period.

The next experiment, ten miles of gutta percha covered wires of various dimension, as regard size of copper and thickness of coating, were employed:—

	Loss of insulation.
No. 1 mile	50° in 1 min. 25 secs.
„ 2 „	50 in 1 „ 30 „
„ 3 „	50 in 1 „ 30 „
„ 4 „	50 in 1 „ 30 „
„ 5 „	50 in 1 „ 26 „
„ 6 „	50 in 1 „ 35 „
„ 7 „	50 in 1 „ 35 „
„ 8 „	50 in 1 „ 0 „
„ 9 „	50 in 0 „ 45 „
„ 10 „	50 in 0 „ 12 „

The ten miles united.

	Loss of insulation.
	50° in 50 secs.
No. 10 mile removed	50 in 1 min. 8 „
„ 9 mile removed	50 in 1 „ 25 „
„ 8 mile removed	50 in 1 „ 35 „

Thus the remaining 7 miles maintained the charge for the same period as the two best insulated miles of the above series. No. 6 and 7 in accordance with previous experiments.

No. 10 mile was again tested by itself with the following result:—

	Loss of insulation.
No. 10 mile	50° in 12 secs.

One mile of india rubber covered wire was also tested by itself, with the following result:—

	Loss of insulation.
India rubber	1° in 2 min.

Both wires, when joined together so as to form a core of two miles in length, gave the following result:—

	Loss of insulation.
Gutta percha and india rubber covered wires	50° in 15 secs.

Here, again, we find that when a wire is exceedingly faulty, the superior wire to which it is united does not assist it to sustain the charge, as it does when the inferior wire maintains the insulation due to the nature and character of its coating.

These simple, infallible, and inexpensive tests, easily carried out, even by an ordinarily intelligent working man, should be applied to all future cables in the course of manufacture, sheathing, transit, and submersion.

While there are ample grounds for believing that the tests hitherto adopted are not of that stringent and searching character, which the importance of the subject demands, it is also evident that the exceedngly complicated nature of the system adopted in testing some of our recent submerged cables, must give rise to unnecessary confusion and uncertainty by the enormous amount of calculation it involves.

Within the last few years the profession of the "Electrician" has almost exceeded in mystery that of the Alchymist of old. With what a flood of new and strange names this simple fluid has inundated the science of Electricity!! Electrician.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.—The stock of Java is being much reduced by large private sales for export.

The market for all descriptions closed for the year at very firm prices.

Gutta Percha still attracts great attention. A private sale of about 50 tons of fine and good genuine have changed hands at higher prices, supposed to be 1s. 9d. per lb.

More enquiries for the middling qualities of reboiled; the holders are keeping back, looking for an advance upon the last price paid of 7d. The stock is now reduced to about 50 tons.

December 26th, 1861. W. Kirkmann.

Gutta Percha.—Several small parcels of good Geneva have been realized this week at a profit of 2d. per lb. bought within a fortnight.

Nearly the whole of the parcels that were in the market held by the importers have been cleared off, mostly bought by the home trade, ending with an advance of 6d. per lb.

Fine and good Genevese (if to be had) 1s. 9d. to 1s. 10d. could easily be realized.

Exports from Singapore to Great Britain, first ten months, from 1st of January to 31st of October.

1858	7,909 peculs.*
1859	14,514 „
1860	15,935 „
1861	8,621 „

India Rubber very firm. The importers show not the least desire to sell.

January 1, 1862. W. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do B. 7 per cent. till 1862	all	13 to 20	———
20	Do. C. „ „	all	9 to 11	———
Stock	Electric Telegraph . .	100	93 to 95	———
20	Red Sea and India Telegraph	all	18 to 19	———
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	———
1	Do. registered . . .	all	3/8 to 5/8	———
10	Do. „ . . .	all	4 to 6	———
5	United Kingdom Telegraph .	2	1d. par.	———
	Mediterranean Extension Tel.	all	3½ to 4½	———
	Telegraph to India . .	1	¼d. to 18 p.m.	———

* A pecul is 133 lbs.

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Proceedings of Societies.

INSTITUTION OF CIVIL ENGINEERS.

Dec. 17.—GEORGE P. BIDDER, Esq., President, in the chair.

Annual General Meeting.—Before commencing the proceedings the PRESIDENT said, that under ordinary circumstances he should have suggested to the members the propriety of adjourning the meeting, in order to testify their regret for the lamented decease of their honorary member, H.R.H. the Prince Consort, and their deep sympathy with their beloved sovereign and the royal family on their bereavement. As, however, the charter imperatively demanded the election of the council and officers on that evening, the council did not feel authorized in postponing the meeting, which would be restricted to the mere routine of the election.

In presenting an account of the proceedings of the Institution during the last twelve months, to which the report was exclusively devoted, it was stated that they would contrast favourably with those of any previous year. The more than ordinary attendances at the meetings showed that the subjects brought forward for discussion had equalled, even if they had not exceeded, in interest those of former sessions. The elections of members and associates had been as numerous, and as a consequence the abstract of accounts exhibited a very satisfactory result. Considerable additions had been made to the library, to which the attention of a special committee of the council had been closely directed.

The principal papers read during the session were then noticed; and it was remarked that many important works, some involving considerable novelty, had been executed by members of the Institution, both at home and abroad, which had never been described. It was, therefore, desirable that every acting and resident engineer, on the completion of any undertaking upon which he might have been engaged, should prepare a descriptive narrative of the progress of the works, of any peculiarities in their design, and particularly of any incidents that might have occurred during their construction.

With a view to encourage the production of really valuable original communications, in preparing the list of subjects for premiums for the season 1861-62, it was determined to offer pecuniary awards not exceeding in amount twenty-five guineas each, in addition to the honorary premiums, for a limited number of papers of distinguished merit. It was hoped that this would have the effect of inducing the presentation of many useful papers, not so much from the intrinsic value of the reward, as from the distinction it would confer on a successful competitor.

With regard to the library, it was stated that the application to the Lords of the Treasury for copies of the Ordnance, and geological maps of the united kingdom had not been successful; the reason assigned being, that their gratuitous supply had been discontinued in 1850, on the recommendation of the late Board of Ordnance, and that the Institution of Civil Engineers could not be made an exception to the rule. No steps had been taken for their purchase, as for the same sum, many books, atlases, and general maps could be obtained, which were likely to be more generally useful. The purchases already made included literary maps of Europe (topographical and geological), of England, Scotland, Ireland, India, the United States, and Canada; and spaces had been left for maps of the world, and of Asia to be added, as soon as the new editions now in hand were completed. Two comprehensive atlases, and a few standard French and English works, especially to complete series hitherto imperfect, have also been purchased. Much useful information had been procured, particularly from the continent, which would facilitate future purchases. Thus there had been obtained from the Ecole des Ponts et Chaussées, a carefully prepared catalogue of works recommended by that school; from the Royal Institution of Holland, a marked list of the best books on water construction; and it was hoped that similar particulars would be shortly received from Germany and Italy. It was on all accounts desirable that the library should be unrivalled in its peculiar speciality; that it should contain copies of all treatises on engineering and the allied sciences, wherever published; and the co-operation of the members generally was earnestly solicited, to enable this to be accomplished.

The abstract of the accounts showed that the amount received from subscriptions and fees was greater than in any previous year, and that the current subscriptions were now 50 per cent. in excess of what they were in 1851. During the year the Stephenson and Miller bequests had been invested in railway debenture stocks, and an addition of £900 had been made to the institution fund, so that the total investments now amounted to £12,194 12s. 11d. The sums on deposit at the Union Bank, and the current balance at the bankers', raised this amount to nearly £15,000.

The amount of arrears of subscriptions due for 1861 was £241 10s., and for 1859 and 1860, £89 5s.; together £330 15s. Great exertions had been made to reduce the sums owing for previous years, and in some cases the arrears had been paid in full, while in others a composition had been made. But still the council had been under the painful necessity, "after suitable remonstrance," of erasing the names of one member, nineteen associates, and two graduates from the register.

The deceases during the year were announced to have been:—Mr. Eaton Hodgkinson, and General Sir Charles William Pasley, honorary members; Sir William Cubitt, Messrs. William Allcard, Samuel Clegg, Nicholas Harvey, Joseph Maudslay, John McVeagh, John Plews, James Ralph Walker, and John Ward, members. Colonel Robert Kearsley Dawson, R.E., C.B., Messrs. George Aitchison, James Braidwood, Charles Frederick Cheffins, Octavius Cockayne, Charles Cowper, Henry Alcock Fletcher, Lionel Gisborne, William Newton, John Pigott Smith, Edmund Treherne, and John Neville Warren, associates.

The number of elections had been 69, of deceases 23, of resignations 9, and of erasures 22, so that the effective increase of the year was 15, making the total number of members of all classes 945. It was mentioned that within the last quarter of a century the number of members of all classes had increased nearly four-fold.

In closing the report, the council urged that the success of the Institution depended a great deal more upon the individual exertions of the members, in support of its scientific character, than upon its pecuniary prosperity; and that it could not continue to hold the high position it had already attained, without efforts and sacrifices being made by the present members similar to those which were so unremittingly and so freely incurred by their predecessors.

After the reading of the report, Telford Medals were presented to Messrs. W. H. Preece, G. P. Bidder, junior, and F. Fox; Council Premiums of Books to Messrs. W. H. Preece, F. Braithwaite, G. Hurwood, and W. Hall; and the Manby Premium, in books, to Mr. G. P. Bidder, junior.

The thanks of the Institution were unanimously voted to the President for his attention to the duties of his office; to the Vice-Presidents and other members and associates of council, for their co-operation with the President, and their constant attendance at the meetings; to Mr. C. Manby, honorary secretary, and to Mr. James Forrest, secretary, for the manner in which they had performed the duties of their offices; as also to the auditors of the accounts, and to the scrutineers of the ballot, for their services.

The following gentlemen were elected to fill the several offices on the council for the ensuing year:—John Hawkshaw, President; J. E. Errington, J. Fowler, C. H. Gregory, and J. R. McClean, Vice-Presidents; Sir William Armstrong, J. Cubitt, T. E. Harrison, T. Hawksley, G. W. Hemans, J. Murray, J. S. Russell, G. R. Stephenson, C. Vignoles, and J. Whitworth, members; and Mr. John Cochrane, and Colonel Simmons, R.E., associates.

The meeting was then adjourned until Tuesday, January 14th, 1862, when the monthly ballot for members would take place, and the discussion upon Mr. Bailey Denton's paper, "On the Discharge from Under-drainage, and its effect upon the Arterial Outfalls and Channels of the Country," would be resumed.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

STANDARDS OF ELECTRICAL MEASUREMENT.

To the Editor of THE ELECTRICIAN.

SIR,—In your issue of Nov. 16, you published a letter from a correspondent very sensibly requiring to know the names of the gentlemen to whom is referred by the British Association the devising of the best standards for electrical measurement. I presume that until you are enabled to make the anouncement, you will continue to publish what electricians may have to say upon the subject.

It appears to me that the "unit of absolute quantity, as applied to statical electricity," proposed by Mr. Latimer Clark and Sir Charles Bright, is particularly faulty; and if it be so, then, of course, their third and fourth standards are faulty also, they being founded upon it. "It is well known," they say "that the quantity of static electricity—that is, electricity under induction, varies, *cæteris paribus*, directly as the difference of tension between the induced and inducing surfaces;" which, by altering the phraseology, may be thus put: *It is well known that the static electrical force acting between an inducing and an induced surface, all other things being the same, varies in the simple ratio of the quantities of electricity in action.* We have here an *inference* substituted for a *fact;* what *ought to be*, according to fallible judgment, put in place of *what is*. The Hon. H. Cavendish in 1772, Sir W. S. Harris by more refined means in 1834, and another electrician experimenting in highly rarified air four years later, all found to be true the very reverse of what in the above quotation is stated to be well known. Sir William, writing in 1853, thus places the fact again upon record;—"The force is always as the *square* of the induction." The eminent telegraphists have obviously ventured an assertion *seemingly* warranted by an axiomatic necessity, instead of turning to experimental certainties which cannot *seem* to be right while they are wrong.

And, apart from the conclusiveness of facts, who can perceive by any *à priori* argument that electricity as *a cause* for physical effects must needs be subject to a mechanical axiom? I shall not be able to believe it must, until I am convinced that the cause for the *physical force* in my arm is subject to the axiom in question, while I know that at one time its first effect is exactly equal to the resistance of a weight supported by it, and at another time equal to a multiple or submultiple of the same amount of resistance. All force that originates physical effects must be put into commission by *what is capable of determining what it shall do;* and what it actually does we can only learn from observation—not necessity.—

AU REVOIR.

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SUBMARINE CABLES.

To the Editor of THE ELECTRICIAN.

SIR,—The government report shows that one of the principal causes of the failures of telegraphic cables, is the rapid destruction of the iron wire covering by sea water. Sir Humphrey Davy found that the copper sheathing of ships could be protected from the action of the chlorine in the water, by simple contact with small pieces of zinc, also that the copper thus protected lost its corrosive and poisonous properties to such a degree that the growth of sea weed upon it seriously impeded the speed of the vessels. An alloy of zinc and copper, similarly durable is, I believe, patented.

This alloy having a far greater power of resisting oxidation than iron; can you or any of your readers imform me why it should not be used in the place of that metal, for the external covering of submarine cables?

W. H. HARRISON.

E. and I. T. Cos. Offices, Haverfordwest.

THE PHENOMENON OF FALSE DISCHARGE.

To the Editor of THE ELECTRICIAN.

SIR,—I have recently read in the columns of the *Philosophical Magazine* (September 1861), a paper upon the above subject by Professor William Thomson, F.R.S., and Mr. Fleeming Jenkin, C.E. The paper is evidently compiled with great care, and reads *learnedly*. The numerous "startling discoveries" which have lately emanated from the same source, have led some of our Electricians to believe that a spirit of *romance* has crept into the stern literature of telegraphic science. It is rather ominous of the fact when we find that almost, if not all the submarine cables, described as endowed with the gift of a "false discharge," have become defunct. Professor Thomson, and Mr. Fleeming Jenkin, have had considerable experience in telegraphic disasters, such as in the case of the Atlantic, the Red Sea, the Corfu cables, &c. As the cause of the so-called "false discharge" has long been satisfactorily and conclusively determined. It is rather amusing to find in the month of September 1861, an attempt made to make scientific capital out of an explained phenomenon.

Your articles upon "Earth Currents" appear to obviate the necessity for any observations on my part relative to the mistaken conclusions advanced in the paper in question. INVESTIGATOR.

Miscellanea.

THE ELECTRIC TELEGRAPH ANTICIPATED.—On looking over the other day some early numbers of *The Spectator*, my eye rested on a paper by Addison, in which he introduces, in his excellent and playful manner, a quotation from Strada, a learned Italian Jesuit, in one of his *Prolusiones Academicæ;* and though, it is true, the story aims at nothing farther than a chimerical supposition of the *instantaneous transmission of thoughts and words between two individuals, over an indefinite space.* and which, when Strada wrote and Addison quoted, never entered into the minds of either as to its *almost ultimate realisation;* yet, as perhaps there may be some persons who may not have particularly noticed this *apparently prophetic forewarning*, I cannot help thinking that the story is worth recording for the benefit of those who have never seen or thought on the subject. It should be observed that Strada tells this story about 250 years ago, and Addison relates it 140 years afterwards. Addison tells us, in the 241st number of *The Spectator*, that "Strada, in one of his *Prolusions*, gives an account of a chimerical correspondence between two friends by the help of a *certain loadstone*, which had such virtue in it, that if it touched two several needles, when one of the needles so touched began to move, the other, though at never so great a distance, moved at the same time and in the same manner. He tells us that the two friends, being each of them possessed of one of these needles, made a kind of *dial* plate, inscribing it with the four-and-twenty letters, in the same manner as the hours of the day are marked upon the ordinary dial plate. They then fixed one of the needles on each of these plates in such a manner that it could move round without impediment, so as to touch any of the four-and-twenty letters. Upon their separating from one another into distant countries, they agreed to withdraw themselves punctually into their closets at a certain hour of the day, and to converse with one another by means of this their invention. Accordingly, when they were some hundred miles asunder, each of them shut himself up in his closet at the time appointed, and immediately cast his eye upon his dial plate; if he had a mind to write anything to his friend, he directed his needle to every letter that formed the words which he had occasion for, making a little pause at the end of every word or sentence, to avoid confusion. The friend in the meanwhile saw his own sympathetic needle moving of itself to every letter which that of his correspondent pointed at. By this means they talked together *across a whole continent*, and conveyed their thoughts to one another *in an instant over cities, or mountains, seas, or deserts.*" Addison goes on to say, "That in the meanwhile, if ever this invention should be revived or put in practice, I would propose that upon the lover's dial plate there should be written not only the four-and-twenty letters, but several entire words, which have always a place in passionate epistles, as *flames, darts, die, language, absence, Cupid, heart, eyes, hang, drown*, and the like. This would very much abridge the lover's pains in this way of writing a letter, as it would enable him to express the most useful and significant words with a single touch of the needle." Now it appears very probable that so close a prediction, though taken under a playful and falsetto view, might in the darker ages have given the *character of a prophet* to good Mr. Strada, to say nothing of our friend Addison, who has thus brought the story before our eyes.—*Notes and Queries.*

NEW ALKALINE METALS.—Cæsium and rubidium are the names of the new alkaline metals discovered by spectrum analysis by MM. Bunsen and Kirchhoff. The Academy of Sciences has received a communication from M. Grandeau, who states that he has had the advantage of making his researches almost under the eyes of M. Bunsen. M. Grandeau began by examining the various mineral waters and minerals, presenting some analogy with the waters of Durkheim, which have yielded cæsium; and with the lepidolite of Rozena, from which the illustrious chemist of Heidelberg has extracted rubidium. The mother waters of the salt-pits of the basin of the Meurthe, of the Mediterranean, the ocean, the Dead Sea, and the mineral waters of Bourbonne-les-Bains and Vichy, were successively subjected to analysis. Sea water and the salt water of the Meurthe only yielded lithia; that of the Dead Sea, lithia and strontian; but the waters of Vichy, of which several thousand litres had to be evaporated, yielded about two grammes of the double chloride of platinum and cæsium, and another of platinum and rubidium, the proportion of which was not ascertained. The quantity of the new alkalies contained in the waters of Vichy is, therefore, very small; but forty hectolitres of the waters of Bourbourne-les-Bains yielded, besides chloride of sodium, various calcareous salts and lithia, a considerable quantity of the chlorides of cæsium and rubidium. Some years ago M. Troost had prepared several kilogrammes of salts of lithia, and preserved all the residues. These, examined by M. Grandeau, furnished him with a considerable quantity of a mixture of the two alkalies in nearly equal proportions. The same result was obtained from a lepidolite of Prague, infinitely richer in cæsium than that of Rozena. Lastly, among the artificial productions examined by our author, there were the residues of the saltpetre manufactory of Paris. From these Captain Caron had extracted a salt of platinum, in which considerable quantities of the new metals were discovered by M. Grandeau in equal proportions. The refuse of a Belgian saltpetre manufactory contained much rubidium without a trace of cæsium. From all this it would appear that the two new elements are much more widely diffused through nature than was previously suspected.—*Galignani.*

To Correspondents.

BAROMETER.—We have endeavoured for some time to utilitise our Peltier for the purpose you suggest. Our mode of operation is as follows:—Having carefully ascertained the temperature, and the hygrometric state of the atmosphere, we charge our Peltier with the aid of a small electrophorus made of ebonite, at given hours of the day or night, until it indicates a tension of say 60°. We then ascertain how many degrees of tension are lost in a given time, say five minutes. The retention of the charge depends upon the electrical state of the atmosphere, whether it has a high or low tension, negative or positive. An approaching change in the atmosphere either causes the retention or the dissipation of the charge imparted to the instrument, according to the nature of this change. We have on several occasions been able to "predict," with some accuracy, the nature of the approaching changes from the readings as above described. The lively or sluggish movement of the needle, when the first charge is imparted to the stem of the instrument, is a test which alone often enables us to determine the electrical condition of the atmosphere. The instrument is easily manipulated, but great care should be taken that it be perfectly free from dust or moisture, especially around the stem, nor should it be breathed upon when charged. We employ chloride of calcium, deposited in small china cups, beneath the glass shade; so as to avoid humidity as much as possible. The brass sphere on the instrument is a small one, not more than three-quarters of an inch in diameter. The instrument is fully described in our 3rd. number.

ENQUIRER.—Professor Wheatstone and Mr. Thomas Allan both exhibited automatic printing telegraphs of very ingenious construction at the Telegraph Soiree of the British Association at Manchester, which were greatly and deservedly admired.

ONE WHO WISHES TO KNOW.—We insert the experiments upon the insulating properties of *tar*. Our experience is in favour of *unmixed* gutta percha as an insulator; we believe it to be more efficient and durable, when pure, than in combination with any other material when submerged in sea water. Gutta percha when employed as an insulator should always be kept under water, or be thoroughly protected from light and atmospheric influences. It is to be feared that several of the cables lost became deteriorated in consequence of the absence of such a precaution.

*** The ELECTRICIAN can now be had in Monthly parts, price 1s. 6d. each.

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The Electrician.

VOL. I. No. 10.—JANUARY 10, 1862.

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DISCURSIVE.

IN the progress to which the present year may be destined to give birth, we anticipate that the science of electricity will take a worthy part. In point of theory, as well as in its immediate application to the purposes of industry and civilization, electricity affords a vast field of endeavour. With regard to the theoretical portion of the science, it has too long been maintained that we are *not yet ready* for facts bearing upon the nature of the electric force, or giving new views of its action upon matter. The feeling which discountenances as presumption any attempt to go beyond the mere observation of facts in electricity, must give way to the desire which now prevails to find an elucidation of these facts in theory. We believe that this elucidation, accompanied by a vast number of facts, of which some are new, and others have unaccountably been kept in the background, will ere long be forthcoming. In its present stage, the science of electricity may be compared to that of chemistry, when the law of definite chemical equivalents was as yet undiscovered. That a discovery of equal importance, which may enable us still farther to abrogate the "rule of thumb" in the application of electrical agencies, may ultimately place the two sciences upon the same level appears more than probable; but such a discovery must be promoted by perfect freedom in accounting for electrical phenomena without any reference to imperfectly established hypotheses, before it can pass through the ordeal of free and searching criticisms, and become an established fact.

With regard to the practical applications of electricity, telegraphic communication will probably continue to be of the first importance. The art of electro-deposition of metals takes the second ground; and the facts on which it is based are susceptible of being applied to a vast number of metallurgical operations. Electricity, which furnishes the key to all chemical reactions, will doubtless be employed in obtaining many rare and valuable compounds which elude the agency of fire, and do not result from the action of ordinary chemical affinities; and for obtaining many of the metals, in a condition of absolute purity, from preparations of their ores, as was dimly foreshadowed by Crosse. Attempts are being made to render electricity a useful servant for every household by substituting the electric wire for the ordinary bell wires; with the advantage of being able to employ a limited code of signals with the ordinary bell apparatus and other contrivances. Batteries of a very inexpensive character may be used for this purpose, remaining in constant action for a period of four or even six months.

Most of our readers have been informed, through the columns of the *Times*, of the proposal of Messrs. Glass, Elliot, and Co., to lay and to guarantee for one year, a cable across the Atlantic from Milford to Halifax, at a cost of £700,000. The offer was made to Government, and *declined*, previously to its being made known to the public. From Milford to Halifax, the distance is greater by some 800 miles than from Valentia to Newfoundland. The claims of the Atlantic Telegraph Company to the support of the Government will doubtless receive full consideration before any contract is entered into for laying a new cable across the Atlantic.

Mr. Latimer Clark, the engineer to the Telegraph to India Company, will leave England for the scene of his labours within a few days. The "Sir James Duke," with 200 miles of cable on board, sailed last week for Aden. The cable was manufactured by Messrs. Glass, Elliot, and Co., within the period of one month. Nothing has been made public respecting the method of construction adopted, or the electrical condition of this cable when shipped.

With regard to the Malta and Alexandria Cable, a rumour has for some time been afloat that the insulation of the wire has become faulty. Owing to the system of secrecy which prevails in telegraphic matters, we have had some difficulty in obtaining authentic information on this subject. It appears that the cable has deteriorated in some degree since it was first laid; at which period, whatever may have been stated, it was by no means in a perfect condition. A moderate number of messages continues, however, to be transmitted through it weekly; and no report of a decidedly unfavourable character has yet been made by those who have the charge of its electrical management.

The London and South of Ireland Direct Telegraph Company have just issued their prospectus. It is proposed to lay from Milford to Wexford, a submarine cable insulated with caoutchouc, under the patent of Messrs. S. W. SILVER & Co. Branches are to be established to Cork and Queenstown, and, we doubt not, to other important towns in Ireland. The merits of india rubber as an insulator of submarine wires, albeit it may still be termed a "new material," have been so fully tested by experiment that we anticipate the fullest success in this important line.

VULCANIZATION.

THE peculiar action of sulphur, and of some of its compounds, upon certain vegetable products, has not yet received an explanation at the hands of the chemist. The discovery of this action in the case of caoutchouc, by Charles Goodyear, resulted in the important process of the vulcanization of this body; which at the present time is most extensively applied in the production of a vast number of useful objects in hard and soft india rubber. This discovery is briefly referred to by Mr. E. T. DUNN, in a pamphlet entitled India Rubber;* and, like many other important inventions appears to have been the result of accident. The accident, however, could have occurred only to "the wonderful man of one idea," or would not have been turned to account save by him. We quote the passage in question from Mr. DUNN's pamphlet:—

"Reduced to poverty and pawn-shop, he (Goodyear) is described as being recognisable 'as a man who has on an india rubber cap, stock, coat, vest, and shoes, with an india rubber purse without a cent of money in it'—an encouraging picture for those to whom he applied for help. But fortune was in store for him. One day accidentally bringing a portion of rubber mixed with sulphur, which he had in his hand, in contact with a hot stove, he found that it had undergone a change such as he had not before noticed, and following up the experiment for some months alone in the factory of Woburn, he discovered the process which makes it proof against cold, and the usual solvents, and, as he himself says, he felt amply repaid for the past, and quite indifferent as to the trials of the future. Perseverance had met with its reward, and the future, though not bright at first, and often clouded by trouble, eventually bore out his hopes to their fullest extent. Not to follow too closely his chequered career, we may here state that although he at once patented his invention, two years elapsed before he could get any one to assist him in bringing it before the public, such was the general aversion to any more experiments with what had hitherto proved so disastrous a failure—a state of things as unfavourable to the promulgation of the discovery as can well be imagined. The interval was occupied by making various improvements, life being sustained by means of divers loans of five and ten dollars, presents of barrels of flour from sympathising friends,

* Effingham Wilson, Royal Exchange.

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pawning even his children's school-books, and other shifts with which poverty is familiar. He felt 'he had now, however, grounds of assurance which had never existed with regard to previous improvements.' 'The discovery was made in winter, and the specimens did not harden. Summer returned, and they did not soften by heat.'"

The picture of the inventor is one with which we are too familiar in the history of many of those whose names should be remembered with grateful appreciation.

Gutta percha is, like caoutchouc, susceptible of the vulcanizing process, though in this case the advantage is not very apparent. Vulcanization is effected either by heat, or by the cold process. In the former case the material is brought into admixture with sulphur, the amount of which may be only a few hundredth parts of the weight of caoutchouc, and heated to a degree which varies according to the nature of the material required. In the cold process the caoutchouc is brought into contact with the sulphide of carbon, or with chloride of sulphur, or both these re-agents.

It is not generally known that the vegetable oils are susceptible of vulcanization by means of the chloride of sulphur. The analogy between these bodies, and those to which we have already referred, may, perhaps, lead to an explanation of the *rationale* of the process, and its application to the formation of new compounds. In 1849, M. Nicles, professor of Physics at Nancy, discovered, also by accident, that the contact of the chloride of sulphur with a vegetable oil was capable of producing a hard compound. In the same year, M. Rochleder also observed the same fact; and subsequently a M. Gaumond made several useful applications of the process. Latterly the subject has been studied in France by M. Perra, from whose researches we obtain the following information :—

By adding to 100 parts of linseed oil, about 25 parts by weight of chloride of sulphur, and agitating the mixture; a compound is obtained, which in a few minutes acquires a very considerable degree of hardness. This compound has been manufactured into various objects, such as small boxes, knife handles, &c., it is not affected by exposure to air, nor by the action of diluted acids and alkalies. It should be stated, however, that it is said to possess a disagreeable odour, which lasts for some time, and also to be somewhat brittle. If subsequently to its formation it be exposed to a degree of heat sufficient to expel any residual chloride of sulphur; it becomes sufficiently transparent, when manufactured into thin plates, to allow of its substitution for window glass.

With a less amount of the chloride of sulphur, a soft and plastic compound is generally obtained. In the proportion of only five per cent., the chloride thickens the oil without hardening it. When the oil is mixed with 30 or 40 times its weight of the *sulphide of carbon*, and to this mixture is added a portion of the chloride of sulphur, equal in weight to one-fourth part of the oil; a compound is obtained, which remains fluid for some days. When the solution is applied to wood, metal, &c., the sulphide of carbon evaporates, and a varnish is immediately produced.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, A.I.C.E.

The precision with which Professor Ohm's laws of the voltaic circuit coincide with, and account for, all the various effects which arise from an alteration in the size or number of plates, amount of resistance, &c., in a voltaic circuit, is already generally admitted, and the equations are given in most foreign works on the electric telegraph. In the few modern works which we possess in English, on voltaic electricity, it is to be regretted, however, that Ohm's formulæ, so important in their bearing on many telegraphic problems, do not often appear, and in these few exceptions they are not dealt with with that detail that their comprehensive nature and importance would merit.

I do not propose, or presume, to supply this deficiency entirely, but it has appeared to me that much may be done to illustrate the comprehensive bearings of this law, by geometrical illustration.

Ohm, in his original paper, makes use of two or three geometrical illustrations in propounding his views, but most of the writers who treat of this important law have even suppressed these.

I believe, however, that not only may the principle general laws be brought forward very explicitly and strikingly, by geometrical illustration and argument, but the various problems that arise in practice, may be solved purely geometrically, whilst some of the laws which regulate the effects of the charge in submarine wires, may also be proved.

I had intended, therefore, originally to attempt simply geometrical illustrations of some of the problems of the voltaic circuit based on Ohm's law, together with some original problems relating to charge; but in my endeavours to commence such an essay, I was gradually led back to the primary and elementary principles which govern accumulation. In thus considering the matter from the beginning, it has appeared to me that in the received explanation of some of the most ordinary electrical phenomena, such as those which occur with a condenser, &c., there exists a discrepancy, when rigidly tested with certain primary axioms which are admitted by most electricians.

I have ventured, therefore, in the present essay and commentary, to attempt a general outline of the principles of electrical accumulation, according to these altered views, based on the axioms to which I allude. These will, therefore, be found to differ in some cases from accepted and published theories; and in such cases I have endeavoured, by argument, to establish my views of the case. This I have followed up with a brief sketch of Ohm's law, sufficient to allow me to pass on to geometrical problems, based on that law, relating both to conduction and to charge in submarine wires. In the projection, as well as in the deductions in some of these cases which I have attempted to solve, I believe will be found some novelty.

I have also endeavoured, as much as possible, to specify the exact meaning to be attached to the technical terms employed, as different writers, I have found, use the same word to imply a totally different meaning. This occurs particularly with the word "tension," which I have, therefore, discussed at some length.

Finally, I have attempted, by geometrical illustration, to exhibit the action which takes place in a submarine wire, causing the retardation of signals.

The attempt thus made to throw any fresh light on such a subject, from mere inductive reasoning and geometrical argument, whilst so many able men have unlimited command of apparatus to bring any fresh view, or theory, instantly to rigid test, may appear, no doubt, somewhat presumptuous, but though in many cases it has been impossible for me to perform the experiments I earnestly desired to test the view in question; yet in most cases, by carefully seeking, I have often found in published experiments examples bearing directly on the subject, although performed with some other view, whilst some other cases I have been able to test by experiment myself. The whole essay is not, therefore, entirely a baseless series of speculations, although, undoubtedly, some of the views may be theoretical.

I must further preface, that if in stating some of the positions, which to some may be doubtful, but which I assume as correct, I have expressed them too much in the manner of a received axiom, and if the style of writing may thus have a somewhat dictatorial appearance, unwarranted by its merits or the position of the writer; this arises simply from a desire for brevity and clearness, which would be unattainable in thus building up a chain of arguments, if couched in terms of repeated caution as to the degree of value to be laid on each position. The whole is but an essay, embodying one person's views on electricity, and the laws previously laid down and received, and as such I offer it to those who may be sufficiently interested in the subject to peruse it.

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Whenever electrical generation occurs, whether by chemical, frictional, or thermal action; exactly equal amounts of electrical action of opposite nature occur on the opposite sides of the source of generation.

Whether we hold the single, or the double fluid theory, the same axiom holds good. If the double fluid theory, then, on each side of the source of generation or separation of the electricity equal quantities of resinous and vitreous fluid must be produced.

In the Franklin, or single fluid theory, then, if on one side of the source a certain quantity of electricity is generated over and above the normal state, then on the other side an exactly equal quantity must be abstracted and if we consider that when electricity is abstracted it may be represented, as in algebra, as a negative *quantity*, we may correctly *speak of a negative quantity of electricity being produced.* In either case, therefore, equal quantities of electricity of opposite nature must be produced.

The terms positive and negative are those in most general use to express the two opposite states, and are those, therefore, which I shall employ.

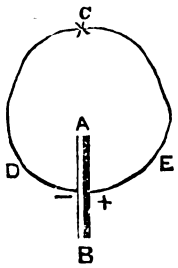
Furthermore, no portion of electricity of either nature can be annihilated without destroying, by combination, an exactly equal quantity of that of the opposing nature.

Whenever electrical generation occurs, there exists always, besides a source of generation, at which the normal electrical equilibrium is just disturbed, certain conditions which allow of the electricity thus separated to re-combine, or else certain other conditions by which the electricity generated is accumulated on two surfaces separated by a medium through which they cannot combine, or can only combine less rapidly than the source can generate.

The first of these conditions is termed *conduction*, and the second *accumulation* by *induction.*

Strictly speaking, in every case of electrical action, both these conditions, and their attendant results exist but in varying degrees, and practically in some cases in such disproportionate degree, that one only becomes the prominent feature in the action.

Conduction may be thus briefly illustrated. Suppose A B (Fig. 1) to represent a source of electrical generation, as for instance, the surface of junction between a zinc plate, and dilute sulphuric acid.



Then if these be joined by a conductor D C E, distinct from the fluid, the electricity separated at A B, would re-combine as fast as generated through the agency of this conductor. Electrical conduction would take place through every part of the conductor D C E. As electrical generation cannot occur without one of the two conditions named, if conduction be practically the only one existing, the quantity of electricity generated in a given time with any given source, must depend on the degree of facility offered for conduction. Now conductors vary in their capacity for conduction, according to certain laws regarding the nature of the material of which they are composed, and their dimensions—which will be detailed further on. Their capacity for conduction is *never* infinitely great, but must always be represented by a quantity, which theoretically could be increased. The amount of generation with any given source, in a given time, can never, therefore, reach its maximum, for however great the capacity for conduction be of the conductor through which re-combination takes place, the generation would with that given source be greater if the conditions for re-combination were greater, but these conditions we have stated are never so great that they could not be *increased.* Conductors, therefore, always oppose in a greater or less degree the generation of electricity, and this power is termed their *resistance.*

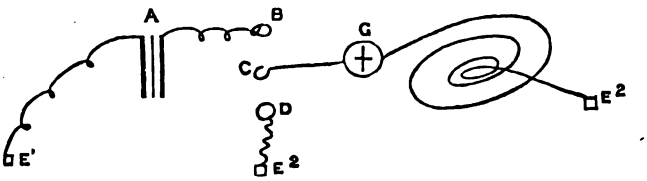
Substances differ in their capacity for conduction in every variety of degree, the specific resistance of some is so great that they give no sensible evidence of conduction, and are termed non-conductors, or insulators, in distinction from those whose specific resistance is, by comparison, so small that they are termed conductors.

There is every reason to believe, however, that all substances really conduct to some degree, although that degree may be so minute as to avoid detection in practice.

(To be continued.)

EARTH CURRENTS.—No. 7.

[Continued from p. 88.]



THE above sketch will enable the reader to follow the various changes made in the disposition and character of the earth plates employed during the progress of the experiments.

A, the battery (1 cell).
B, battery wire.
C, long wire leading through galvanometer G.
D, wire leading to earth.
E^1, earth plate to battery A and wire B.
E^2, earth plate to wire C.
E^3, earth plate very thin wire to long wire.
G, galvanometer.

The copper wire between galvanometer G and earth plate E^3 was two miles in length suspended in open air, as already described.

In the first experiment, earth plate E^1 was of iron; earth plate E^2 of zinc; and earth plate E^3 of copper.

When C and D were brought into contact the needle of the galvanometer G was deflected permanently, but with a slight tendency to vibration, 3·2° to the left, but upon rapidly bringing B and D into contact with C, with the aid of a rotary reverser, the needle was deflected to the right 70°, but gradually changed its deflection to the left, as the action of the reverser became slower.

For the iron earth plates, E^1 and E^3, copper plates were now substituted.

When C and D were brought into contact the permanent deflection of the needle of galvanometer G was 10° to the *right*, and by rapidly charging and discharging C, as above described, the deflection was always to the *right.*

It has been stated above that the earth plate attached to long wire C consisted of a short coil of thin wire about ½-ounce in weight, upon attaching an additional ounce of copper to the coil, and C and D were brought into contact the deflection on the galvanometer was reduced to 5° *to the right*, instead of 10° as in the previous experiment, and only a slight increase took place when the rotary reverser was employed. When an additional half-an-ounce was added to earth plate E^3 the deflection was again reduced to 4° right, and by adding two ounces more reduced to 2° right, the employment of the reverser caused but a very slight difference, as in the previous case.

The earth plate E^2 was removed and the wire attached to a large mass of iron consisting of hydraulic machines and pipes fixed upon a wooden platform, but connected to earth by means of iron bolts, presenting a small surface. When C and D were brought into contact the permanent deflection was 16° to the left, but when charged from battery A and discharged into earth E^2 the needle deflected 50° to the right.

The distant end of long wire C being removed from the hydraulic pipes it was attached to the gas pipe, the deflection was now 13° instead of 15° to the left, and by rapid charging and discharging, with battery

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power, the deflection could not be increased, the tendency being to decrease, and repeatedly the deflection was reduced to zero.

The current passing between E^2 (gas pipe) and E^3 (copper plate) caused the needle to deflect 14° to the *left*, while current from E^1 (copper plate) through battery A to E^3, caused a deflection to the *right* of 36°.

E^3, copper plate, was replaced by a coil of iron wire; the current passing between E^2 and E^3 produced a deflection of only 6° to the *left*.

Gaspipe of E^2 was changed for a copper plate; the current passing between E^2 and E^3 now caused the needle to deflect 24° to the right, and by bringing battery wire B and earth wire B into rapid contact with C, by means of the rotary reverser the deflection was increased to 55° to the right.

The current which passed between E^2 and E^3 gave a deflection of 24° to the right between E^1 and E^3 through two cells 52° to the left.

E^2, copper plate, was again replaced by the hydraulic pipes, as already described, the current passing between E^2 and E^3 caused no deflection, but in about half-an-hour 2° appeared to the right.

The battery being dispensed with, the experiments were continued as follows, various earth plates of nearly the same size and weight were provided, consisting of iron, copper, and zinc.

E^1 iron to E^3 iron—deflection 3° to right.
E^2 iron to E^3 iron—deflection 3° to right.
Rapid reversals between E^1, E^2, and E^3, no increase of deflection.
E^1 iron to E^3 iron—deflection 3° to right.
E^2 copper to E^3 iron—deflection 41° to right.
Rapid reversals, &c., 25° to 30° to right.
E^1 copper to E^3 iron—deflection 30° to right.
E^2 copper to E^3 iron—deflection 41° to right.
Rapid reversals, &c, 30° to 40° to right.
E^1 copper to E^3 copper—deflection 12° to right.
E^2 copper to E^3 copper—deflection 3° to right
Rapid reversals, &c., 1° to 6° to right.
E^1 iron to E^3 copper—deflection 23° to left.
E^1 copper to E^3 copper—deflection 3° to right.
Rapid reversals, &c., 15° to 20° to left.
E^1 iron to E^3 copper—deflection 19° to left.
E^2 zinc to E^3 copper—deflection 38° to left.
Rapid reversals, &c., 20° to 40° to left.

One cell being introduced between E^1 and E^3 the deflection was 37° to the right, and by making rapid contacts between E^1, E^2, and E^3 by means of the reverser, the needle deflected sometimes to the left and sometimes to the right. Three cells gave a decided deflection on one side, overpowering the current passing between E^2 and E^3.

It will be observed that the battery charge gave a deflection of 37° to the right, and when the long wire, after being so charged, was brought into contact with the earth wire E^2 the deflection instantly changed to the left 38½°, and by making rapid contacts between the long wire the battery and the earth, the deflections were irregular.

THE FAILURE OF THE ATLANTIC CABLE.

The following report was made by Mr. C. F. Varley upon the condition of the Atlantic cable after it had ceased working. We shall in a future number quote the equally instructive report of Mr. W. T. Henley upon the same subject; as both may with advantage be studied by those who have acquired some knowledge of electrical science with a view to its practical application.

Report on the State of the Atlantic Telegraph Cable.

London, *Saturday, September* 18, 1858.

I arrived at Valentia on the evening of the 5th inst., when I found that no words had for many days been received through the cable from Newfoundland.

On the 6th, 7th, 8th, 9th, and 10th, I tested the cable at intervals in four different ways to ascertain its condition. The following are the results:—

1. There is a fault of great magnitude at a distance of between 245 and 300 statute miles from Valentia, but the locality cannot be more accurately ascertained until a portion of the cable, 20 or 30 miles in length, has been tested against my standard of resistance, and until the log has been consulted to ascertain the amount of slack paid out. I would suggest that the piece of cable at Greenwich be carefully measured and tested against my standard, in order to obtain the most correct estimate of the distance of the fault. Assuming, however, that it is 270 miles, and allowing 22 per cent. for slack, it is possible that the chief defect is in shallow water—410 fathoms.

2. The copper wire at the faulty place, above alluded to, does not touch the iron covering of the cable, as is proved by its forming a voltaic element, which gives rise to a continuous positive current from the copper wire varying very little in tension.

3. The insulation of the wire between Valencia and the fault, is perfect, or at least contains no defect of sufficient importance to be perceptible, or to materially influence the working were the cable otherwise perfect.

4. The copper wire is continuous, and consequently the cable has not parted. Faint signals, or reversals, are still received from Newfoundland, but the power used will shortly eat away the exposed copper wire in the faulty place by electrolytic decomposition.

The actual resistance of the fault appears to be at least equal to ten miles of the cable, but is most probably greater.

Taking it at its lowest resistance, viz., ten miles, and assuming that Newfoundland is only using 180 cells of Daniell's battery, the strongest current received thence during may stay was only a 24th part of the force that it should be were there but this one fault. When it is, however, borne in mind that on the other side they are probably using more power, and also that the defect first alluded to probably offers more resistance than that assumed, viz., ten miles, it is evident that there is another and more distant fault, the approximate locality of which I could not pretend to estimate at this end without being able to speak to Newfoundland.

From authentic *data* shown to me at Valentia, I am of opinion that there was a fault on board the Agamemnon, before the cable was submerged, at a distance of about 560 miles from one end, and 640 from the other.

The following are the *data* in question, but on what occasion they were obtained, I am unable to state. They were, however, probably taken when the ships were at Queenstown:

Testing of Coils on board the Agamemnon, consisting of about twelve hundred statute miles of Cable.

1. When the upper end was disconnected, the current entering the cable from a battery, was..... 8·5 parts.
2. When the upper end was put to earth, current entering the cable was..... 10·5 parts.
3. Current going out of upper end of cable to earth..... ·5 parts.
4. When the lower end was disconnected, the current entering the cable was..... 8·5 parts.
5. When lower end to earth..... 10·5 parts.
5. Current going out of upper end of cable to earth..... 4·5 parts.

Showing that, if there were a fault, it was nearer to the upper end, but not far from the middle of the coil.

When 200 miles had been removed from one end of the coil (but from which end I am not at present aware), leaving 1,000 miles, the amounts were:—

1.....	7·5 parts.	4.....	8·5 parts.
2.....	10·25 parts.	5.....	11·5 parts.
3.....	6·5 parts.	6.....	6·5 parts.

Indicating that there was a fault, by rough calculation, at about 560 miles from one end, and 440 from the other.

With the 200 miles of cable amounts were:—

1.....	2 parts.	4.....	— parts.
2.....	40 parts.	5.....	40·5 parts.
3.....	39·5 parts.	6.....	39·5 parts.

Test of the entire Cable on board the Agamemnon and Niagara—viz., twenty-five hundred miles

BATTERY AT AGAMEMNON END.

1. Current entering the cable, the Niagara end being disconnected..... 45 parts.
2. Niagara end to earth..... 49⅔ parts.
3. Current flowing out at Niagara end to earth..... 15½ parts.

BATTERY AT NIAGARA END.

4. Current entering cable, Agamemnon end being disconnected..... 35⅜ parts.
5. Agamemnon end to earth..... 37 parts.
6. Current flowing out at Agamemnon end to earth..... 14 parts.

Indicating considerable leakage on board the Agamemnon.

I am also informed that the currents through the cable, even immediately after it was submerged, were so weak that relays were useless, and that not one perfect message was recorded by them, everything that was received being read from the reflections of a galvanometer.

By comparing the above *data* with those of the new cable now making by Messrs. Glass and Elliott, for the Electric and International Telegraph Company, the amount of current which entered the 1,000 miles of cable when disconnected at one end should not have exceeded 2 or 2·5 parts, instead of 7·5 and 8·5 parts.

The inference by rough calculation, therefore, is that there was a

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fault offering a resistance equal to 1,000 or 1,200 miles of cable, situated at a distance about 560 miles from one end of the 1,200 mile coil on board the Agamemnon.

This, however, cannot be the fault first alluded to, situate at about 270 miles from Valentia, but may have been the one which caused such alarm when the ships were 500 miles from Ireland, and when the signals ceased altogether and never certainly recovered.

It is not at all improbable that the powerful currents from the large induction coils have impaired the insulation, and that had more moderate power been used, the cable would still have been capable of transmitting messages.

To satisfy myself on this point, I attached to the cable a piece of gutta percha covered wire, having first made a slight incision in the gutta percha to let the water reach the wire; the wire was then bent so as to close up the defect. The defective wire was then placed in a jug of sea water, and the latter connected with the "earth." After a few signals had been sent from the induction coils into the cable, and, consequently, into the test wire, the electricity burnt through the incision, rapidly burning a hole nearly one-tenth of an inch in diameter.

When the full force of the coils was brought to bear on the test wire by removing them from the cable, and allowing the electricity only one channel—viz., that of the test wire, the discharges, as might be expected, burnt a hole in the gutta percha under the water, half-an-inch in length, and the burnt gutta percha came floating up to the surface.

The foregoing experiments prove that when there are imperfections in the insulating covering, there is very great danger arising from using such intense currents.

The size of the present conducting strand is too small to have worked satisfactorily even had the insulation been sound. With a strand of larger dimensions less intense currents would be required, and both speed and certainty increased.

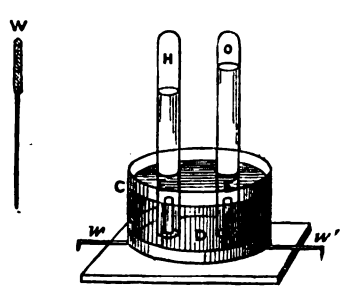
It is not, however, altogether impossible that some intelligible signals may yet be received through the cable, as stated in my previous communication.

C. F. VARLEY,
Electrician of the Electric and International Telegraph Company.

The Student.

VOLTAIC ELECTRICITY—*continued.*

Electrolysis—The Voltameter.—The decomposition of a fluid, or of bodies held in solution by a fluid, by means of electricity is termed *electrolysis.* For the electrolysis of water, the following apparatus, in which the oxygen and hydrogen gases are separately collected, may be constructed:—

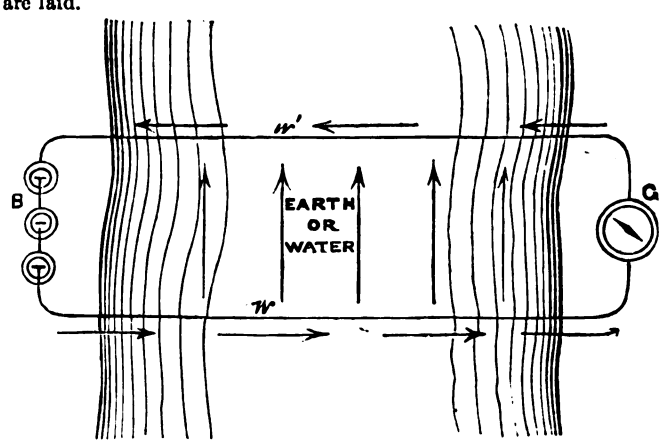


A cylinder of glass, C, may either be obtained at the glass works, or formed by removing the neck and bottom of a broad vial and grinding upon a stone. Two pieces of stout platinum wire, four or five inches in length, and two tubes, H and O, which may be made from a piece of glass tubing by heating this in the middle before the blowpipe, are also required. For an inch or two of their length, the platinum wires are to be flattened under the hammer. A dish of sheet gutta percha, D, forms the bottom of the cylinder, and is made to take the form of, and to adhere to, the glass by the application of boiling water. The platinum wires are then heated and forced through the gutta percha in the interior of the cylinder, so that the flattened portions may form the electrodes E and E'. When cool, the wires are bent at right angles so as to project at *w* and *w'*. The extremities may thus be inserted into the mercury contact cups; or the ends of the wires from the battery may be twisted upon them. The stand of the instrument may be a square piece of gutta percha; the surface of which is softened and made to adhere to the bottom of the cylinder by means of a hot iron. A wooden or cardboard cover may be adapted to the cylinder, with two round apertures to receive the tubes and to maintain them in position. The extremities of these tubes should not fit closely to the gutta percha, or the resistance to the passage of the current will be very great. The apparatus, which is termed a Voltameter, and which serves approximatively to measure the force of a voltaic current by the volume of the gases evolved, is used as follows:—

Exp.—To twelve parts, by volume, of water add gradually one part of sulphuric acid. When the mixture has cooled sufficiently, the vessel may be nearly filled with it. The two tubes H and O are then filled; and, the extremities being closed with the finger, inverted into the fluid in the cylinder so as respectively to cover the two electrodes. Connect the poles of a battery with the wires *w* and *w'*; oxygen and hydrogen will be evolved from the electrodes and collected within the glass tubes in the proportion of one volume of oxygen to two of hydrogen. The properties of these gases may be tested, when the tubes are filled or partly filled, by means of a lighted match. In oxygen the wood will burn with a flame of greatly increased volume and splendour; in hydrogen it will be extinguished, and the gas will burn with a blue lambent flame.

Electrolysis of metallic solutions—Electro metallurgy.—We have seen, p. 42, that when the extremities of the copper terminal wires of a voltaic battery are placed in a solution of sulphate of copper, the end of the positive wire becomes corroded or dissolved, while the end of the negative wire becomes coated with reduced copper. This effect is due to the decomposition of water, rendered a comparatively good conductor of electricity by the presence of the metallic salt. Its application has given rise to the important art of electro-metallurgy, a branch of the science of electricity which is of the utmost interest to the student. The negative element of the Daniell's battery becomes covered with copper by electro-deposition. If the reduced copper be detached from the plate, every scratch or mark upon the latter will be found reproduced in relief. Thus, if a copper coin be made the negative element of a Daniell's couple, the coatings on either side, when detached, from a mould in which a perfect copy of the coin may be cast in fusible metal or plaster. By coating plaster, sulphur, or other non-conducting substance with plumbago, which is an excellent conductor of electricity, we are enabled to form of these bodies an efficient negative voltaic element, and thus to give to them a coating of reduced metal. Or they may be attached to the negative terminal of the battery and immersed in the metallic solution; the positive terminal being connected with a strip of metal, which becomes gradually dissolved and thus serves to maintain the strength of the solution. In electro-plating with silver a strip of silver is attached to the positive terminal; in electro-gilding, a strip of gold, &c. A solution of sulphate of copper will answer the first experimental purposes of the student in electro-metallurgy; but, in practice, a solution of the *cyanide* of this or other metals, in cyanide of potassium is found best to answer the purpose required. For the present we will refer the student desirous of following this interesting branch of study to the treatise on Electrotype Manipulation by Mr. W. Walker, published by Messrs. Knight.

Telegraphic Circuit—Insulation of Telegraph Wires.—We will now resume the subject of telegraphic circuits, with reference to the question of insulation, Let the following figure represent a complete wire circuit;—B the battery, w the wire from the positive pole, G the galvanometer, and w the return wire; the space intervening between the battery and the galvanometer being earth or water, in which the wires are laid.



Supposing both wires to be insulated, or in free electrolytic contact with the earth; it is obvious that the moisture of the soil will constitute a fluid conductor between them. The wires, in fact, form the

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two electrodes of the battery; the electrolyte being the fluid of the earth. A portion of the electricity conveyed by the wires will, therefore, pass from one wire to the other without traversing the metallic circuit, or, in other words, the battery circuit will be completed partly through the wire and partly through the earth. According to the amount of resistance offered by either of these conductors will be the quantity of electricity passing through them respectively. In a short circuit, say of a few hundred yards, the amount of the surface of the electrodes, viz., the naked wires, remains inconsiderable; while the resistance offered by the wires is small in comparison to that of the fluid between them. The greater portion of the current will, therefore, traverse the wires, and its effect will be seen in the deflection of the needle of the galvanometer. Thus, by making and breaking contact of either of the wires with the battery, signals may be transmitted across the intervening space. In increasing the length of the wires in longer circuits, we both augment their resistance and the amount of their surface in contact with the earth, i.e., we increase the resistance of the wire circuit and diminish that of the earth circuit. We therefore quickly reach a point where the resistance of the earth becomes insignificant compared to that of the wire. No appreciable current will then pass through the galvanometer, and no signal can, in consequence, be transmitted. If we now increase the tension of the current the galvanometer will still remain unaffected; the effective resistance offered by the earth to the passage of the current, being thereby decreased in greater degree than the effective resistance of the wire. By augmenting the *quantity* of the current we may obtain further deflections; but here again a point is ultimately reached when no further signals can be transmitted, the wire having obtained its maximum charge of electricity of the given tension.

Let *one* of the wires now be *insulated*, or covered with a substance, such as gutta percha or caoutchouc, which impedes, the passage of electricity from the wires to earth. According to the perfection of the insulation will the escape of electricity from one wire to the other be prevented. Providing the conductor be sufficiently large, or the tension of the current and the degree of insulation sufficiently great, it thus appears possible to transmit telegraphic signals along a wire to any distance. The employment of a current of very high tension is, however, attended with much danger of impairing the efficiency of the line; and for long distances a large conductor should therefore be employed. As we have already seen, the second, or return wire, may be advantageously dispensed with, the earth being used for one half of the battery circuit. With a complete circuit of *uninsulated* wire, signals may, by the use of certain precautions, be transmitted to a distance of three or four miles, or perhaps even to a greater distance, but such circuits have never been practically adopted even for signalling to a short distance. In the latter case, the waste of battery power and its expense would have to be taken into account against the saving effected by the useof an uninsulated wire.

PROSPECTS FOR THE ATLANTIC TELEGRAPH.

[From the MORNING CHRONICLE]

IT is mentioned that arrangements are in contemplation for attempting a renewal of the attempt to provide telegraphic communication between England and America, by way of Halifax. Of the enormous value which an Atlantic telegraph would be to this country, recent events have enabled us to judge. It is not too much to say that if an Atlantic telegraph had been in operation, the affair of the Trent would, before this time, have received an amicable settlement, for the Government at Washington would have long since known the determination at which we had arrived, and the preparations which we were making to give force to our demands, and mutual explanations would have taken place that would have led to the disavowal of the act of Captain Wilkes. The question is now seriously asked whether there are really any insurmountable difficulties in laying a submarine telegraphic cable across the Atlantic, and it may be useful to ascertain what are the facts that affect this question. A short time since a joint committee was appointed by the Board of Trade and the Atlantic Telegraph Company to inquire into the whole subject, and their report will be found to contain much useful information on the subject. The report states that the date at which the committee concluded their labours 11,364 miles of submarine telegraph had been laid, and that of this extent about 3,000 miles were actually at work. Of the total quantity laid 3,074 miles were in shallow water, and 8,290 were deep sea cables. If we look more closely into the figures, it appears that of the 8,000 miles which have failed, as much as 6,940 belonged to four companies—the Atlantic Telegraph Company sank 2,200 miles; the Red Sea and India lines, 3,499; the Sardinia, Malta, and Corfu, 700; and the Singapore and Batavia, 800 miles. Of these lines, however, all are not considered as hopelessly lost. Of the six sections of the Red Sea cable there is reason to believe that they may be repaired and again set in working order, and a company has recently been formed for the purpose of undertaking these repairs; the Government having given up to them, on very favourable conditions, its claim to the telegraph. The failure of the Atlantic cable was due, in a great measure, to its most defective construction, and the inefficiency of its insulation. It was subjected to a great deal of very rough usage before it was finally submerged; it was shipped, and unshipped, and reshipped, and even when it was finally laid, the most sanguine of the party of electricians on board could scarcely hope to be able to transmit a current along the whole distance, owing to the many injuries which the cable had sustained. The Malta and the Alexandria cable, which has recently been laid at the cost of the Government, has been laid with great care, and under the supervision of engineers appointed by the Board of Trade. That line is in working order, and has been so from the time of its submergence. This affords reason for believing that with care and caution, and the use of the best materials that can be obtained for the purpose, deep sea cables may be laid for great distances, and worked with efficiency. The cable of 800 miles, which was laid by the Dutch Government between Singapore and Batavia, was, for the greater part of the distance, in shallow water, and the principal injuries which it sustained were from the dragging of anchors. In every case in which failure has occurred, scientific men have been enabled to discover the precise cause; and on examining their reports it will be found that, in each and every case, the failure has arisen either from defective workmanship, the use of improper materials, or carelessness and the want of accurate knowledge respecting the locality on which the cable was to be laid.

The greatest of all the difficulties with which the electricians have had to contend, is that of finding a material which will ensure perfect insulation. It is asserted that the substance employed for this purpose should possess qualities which are not easily found in combination. They must be free from impurities or foreign substances; free from cavities and air holes; perfectly homogeneous; capable of being easily and effectually joined in parts; not affected by temperature, nor deteriorated by elongation, unimpaired by immersion in water; it must be of light specific gravity, and possessed of great insulating power. Gutta percha has been the material which, with one or two small exceptions, has been employed in the manufacture of submarine cables, and to its imperfections are due the many failures which have thrown so much discouragement over undertakings formed to carry out submarine telegraphs. The committee state in their report that the failures of the most extensive lines of submarine electric telegraphs have become manifest almost invariably by a gradual decrease of insulation, and that in repairing these lines it has generally been found that the gutta percha has become disintegrated by the electrolytic action of the current employed in working the line, in places where the thickness of insulating material had been originally below the average, owing to some mechanical injury, or more frequently owing to a cavity in the material forced into by the water. One witness, speaking of the failure of the Red Sea line, says that there was in the gutta percha some fissures or faulty place, which, by a slight extension of the cable, admitted the water near enough to the conductor to produce defective insulation, but which closed again by the elasticity of the gutta percha, until, by the continued action of the electric current, a partial disintegration of the protecting film of insulating medium was produced. Another, and a larger fault, appeared in the section from Suakin to Aden, which was in the gutta percha, produced evidently on board ship. Another witness observes:—"I think, from what I have seen lately of faults in gutta percha, that my confidence is entirely gone. I would never undertake to lay down a cable lain in gutta percha, the faults have been so great and so frequent that I have not the least confidence in it." And this witness had laid in all upwards of 10,000 miles of such cables. As this material has been found so unsuited for the purpose, it has been suggested that a trial should be made upon an extensive scale of india rubber. It so happens that the very first submarine cable which was laid was insulated with that material. It was a short line to the Isle of Wight from Portsmouth, and portions of the cable have been found to be as perfect in their insulation as they were when first laid down ten years since. A number of experiments have been made which have proved how complete are the insulating properties of india rubber, and how well it is adapted for the purposes required. It would be curious indeed if the first really efficient insulating substance that was used should, after falling entirely into disuse, be now again brought forward. As in the case of

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the copper for the conductor, so india rubber appears almost specially intended for the purpose of insulation. The substance possesses insulating qualities of the highest order. It is tough, highly elastic, of less specific gravity than water, easily manipulated, extremely durable under water, nearly impervious to moisture, except superficially, and not costly. As a test of the value of this material is one of the chief properties, we may state that some insulators, formed of ebonite, upon a principle patented by Messrs. Silver and Co., were fixed upon poles for the purpose of testing, in conjunction with insulators of glass and porcelain. The results were of the most remarkable and encouraging description. The loss upon the porcelain insulators was represented by 144 degrees, while that of the ebonite was but 1·50, or very nearly one hundred times less than that of the other material. These experiments extended over a period of several months, and subject to numerous atmospheric changes. As compared with glass the results were still more in favour of india rubber. We only refer to this as evidence of the perfection of the insulating qualities of the substance—qualities which will be as severely tested above ground as in water. If we advance another stage it will be found that the conducting wires, coated with india rubber possess an amount of conducting power far greater than those covered with gutta percha. The thin lines which now metal over almost every part of the metropolis in connection with the Universal Private Telegraph Company, consist of strands of thirty wires each, coated with india rubber, and coiled as a rope; but so perfect is the insulation, and so thoroughly distinct and separate is each strand, that thirty electric currents may be flung through at the same instant of time, without the slightest difficulty in the working of the line. Professor Wheatstone says:—"India rubber surpasses all other materials in the smallness of its inductive discharge, and the perfectness of its insulation. In the former respect, a coating of india rubber is fully equal to a coating of gutta percha of double its thickness; and in the latter respect its comparative advantage is still greater." The report of the committee, to which we have already referred, states "that the insulation is superior to anything that has before been attained." A good deal of this is due, no doubt, to the admirable manner in which these wires are manufactured, but which has been done at the Telegraph and india rubber works at Silvertown, has been accomplished by a desire to spare no pains, either in workmanship or material, in order to obtain a satisfactory result. A gentleman, who is now no mean authority on the subject of telegraphs, we mean Mr. Reuter, informs us that the thirty-strand cables have answered perfectly; that "neither the severe cold of last winter nor the great heat of the summer affected it in the slightest degree. The electric current has, in fact, passed freely through it in all changes of the temperature without experiencing any interruption." With respect to the action of water in destroying the insulation of india rubber, the result of many experiments has been to show that the material is equally valuable for that purpose in water as in air. The report of the committee states upon this point:—"The absorption only reaches a small depth, and does not destroy, or in any way impair, the insulating power of that portion of the caoutchouc which is beneath the moistened layer. . . Our conclusion, from a careful consideration of these and other experiments, is, that the absorption of water is not to be feared as a cause of deterioration, and that pressure improves the insulation, and there appears to be less difference in india rubber when subjected and not subjected to pressure than in any other material."

Upon a careful consideration of all the facts bearing upon this important question of submarine telegraph we think there is yet a prospect for the deep sea lines, and we believe that the time is not far distant when renewed attempts will be made to connect by telegraph the old and new world.

COAST TELEGRAPHS.

THE necessity of a comprehensive system of coast telegraphs has long been felt by the shipping interest of the country, and at the present time when threatened with the ravages of war, that necessity becomes daily more painfully apparent. Our coast guards and Royal National Life Boat Society's stations and our numerous lighthouses might be advantageously united by telegraph, so that the appearance of an hostile force, upon any part of our coasts, could be instantly telegraphed to our various naval stations. A coast line might also be employed for meteorological purposes in communicating notices of approaching storms, &c.; the placing of our numerous lighthouses in telegraphic communication with each other and with land is a subject which has long engaged public attention as likely to afford valuable assistance in averting the recurrence of the calamities of shipwreck. Vessels in distress are frequently spoken with as they approach our lighthouses, but as there exists often no means of communication between those establishments and the land, or the next life boat station; the vessels are deprived of the humane and timely aid provided for their succour and for saving the valuable lives placed in jeopardy and peril. The expense of constructing a system of telegraphs for effecting the objects above briefly enumerated, would be amply compensated by the valuable informations afforded the shipping and commercial interests, and by the immense saving of property and lives along our coasts.

MR. REID'S PRESSURE TANK, USED IN TESTING CABLES DURING MANUFACTURE.

HAVING some years ago employed, at different times, several modes of testing telegraph wire for submarine purposes, such as immersing it in the sea at different depths, &c. this plan I found a great improvement over the common method that was practised at the gutta percha works, where it was tested in the canal with seldom more than 12 inches of water over the coil of wire.

The plan of testing in the sea, however good, has some disadvantages, such as stormy weather, the danger of having the wire injured on board ship, or in the transit to and fro, &c. I have therefore adopted the following plan, which for simplicity and giving a fair partial test of wire to any extent required, seems to provide for all contingencies that may arise in making telegraph cables effective.

First, I take a strong iron vessel capable of containing five miles of core; it is made air and water tight, and is fitted with a number of air-tight stuffing boxes, for the purpose of passing the ends of the wire out from the cylinder and connecting them with a galvanometer. The vessel is also fitted with gun-metal valves at top and bottom, for the purpose of exhaustion and for filling and discharging the water from the cylinder. This vessel weighs in round numbers seven tons.

To explain the working fully, I fill the cylinder from the top with as much wire as it will contain, bringing the ends of the several coils or drums through the stuffing boxes; I then put on the cover of the cylinder and bolt it down, having a ring of india rubber for a joint. The air-pump, which is worked by steam power, is then applied, and a vacuum formed by exhausting all the air contained in the cylinder, and also that of the gutter percha or other core. Hitherto gutta percha has only been employed, and it is found that in the process of manufacture a considerable quantity of air has been mixed up with it, forming what is called air bubbles, and sometimes to be in places porous and spongy; in all such places the cavities are filled with air which at times have nearly reached the conductor, and in many cases must have proved fatal to the telegraph. To remedy this defect the object of the air-pump is to remove all the minute particles of air. When the vacuum is considered perfect, as shown on the vacuum gauge, the exhaustion pipe is closed and the valve opened for the admission of water, which at once fills the cylinder and occupies the space in the gutta percha formerly filled with air. At this stage of the proceedings the galvanometer is carefully noted and the deflection recorded. I now bring the hydraulic pump into action, and exert a pressure equal to 600 pounds on the square inch, and after this pressure has remained for ten or fifteen minutes the galvanometer is again recorded, and if it remains quiescent you may consider the cable safe for a depth of 250 fathoms; the pressure is still continued till it equals a column of water whose height is equal to the depth of the sea where the cable is to be laid, adding a sufficient margin to the pressure to make it perfectly safe, on the same principle as testing a beam or girder that is to carry a given weight, the pressure must exceed this weight, or its safety becomes endangered. If we suppose the cable destined for the Atlantic, and the depths to be 2,000 fathoms, equal to 12,000 feet, the pressure applied in this case would be 5,295 pounds on the square inch, equal to 2 tons 7 cwt. 1 qr. 3 lbs. When this pressure has remained on for fifteen minutes, again note the galvanometer, and if still quiescent your cable is sound, and may safely be immersed to the required depth. When the wire is removed from the cylinder it must be carefully wound off one drum on to another, passing through the hands of a careful operator, who will find a slight indentation on the surface where the pressure has acted on a crevice containing air. He must pass a thin sharp knife under this indentation and reach the bottom; if only slight it may be tooled up and restored; if it is a serious flaw it must be cut out, and the cable proceeded with. The further advantage of this process of testing is, that the flaws and defects are all discovered at an early stage of the cable's progress, and before the expensive process of covering the cable with iron or steel wire has commenced, and the detection becomes more difficult.

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The engineer has now the satisfaction of knowing that he has a perfect core, and that when laid in the ocean's deep it will not be subjected to any more pressure than has already been upon it, and that if carefully laid and free from mechanical injury, the cable will work satisfactorily and fulfil all the conditions that are anticipated from it.

The great and crying evil with all deep-sea telegraphs hitherto made was the careless and hurried manner they were executed, without a proper amount of inspection and supervision.

I may observe, that some people are of opinion that a cable to be perfect ought to be tested by the above-named process after it has received its iron or hemp covering. This can be done while passing it on board of ship; it only involves a great amount of time and additional expense.

The cable constructed for the Government, and recently laid between Malta and Alexandria, and the one for the French Government from Toulon to Algiers, I consider the best cables that have yet been made. No pains or expense have been spared to render them effective. They have been very carefully tested, and every coil on which rested the least suspicion has been rejected; and if carefully laid will redeem the credit of this country from the many failures that are recorded against submarine telegraphy.

IRREGULARITY OF BATTERY CELLS.

The following measurements of the quantity of the current from each cell of a battery contained in 12 troughs of 12 cells each, show the necessity of a careful examination of the power of a battery when employed for experiment.

A Galvanometer or Detector with one quantity Coil employed.

		1st cell.	2nd cell.	3rd cell.	4th cell.	5th cell.	6th cell.	7th cell.	8th cell.	9th cell.	10th cell.	11th cell.	12th cell.
No. 1	Battery.—	49	50	50	40	42	42	44	41	44	44	37	34
No. 2	„	35	46	45	37	45	40	40	43	47	48	47	50
No. 3	„	50	47	44	50	43	48	46	51	40	40	47	45
No. 4	„	49	41	42	39	44	41	40	43	45	40	48	52
No. 5	„	40	47	46	42	42	44	42	47	48	39	44	43
No. 6	„	40	45	44	45	41	48	45	41	46	45	48	51
No. 7	„	53	40	36	44	47	45	47	45	40	50	39	47
No. 8	„	50	44	37	37	40	43	45	37	45	41	43	38
No. 9	„	51	44	41	39	40	46	35	44	42	41	40	43
No. 10	„	50	40	42	44	41	42	45	44	44	41	42	38
No. 11	„	50	40	40	41	48	41	34	49	45	47	38	41
No. 12	„	49	36	40	43	41	40	40	37	35	44	49	35

THE WARRIOR AND HER COMPASSES.

The following paper was read by Mr. F. J. Evans at the meeting of the British Association at Manchester. The subject of ships' compasses is now obtaining a great amount of attention in other quarters:—

"It may be considered interesting to the meeting to receive a brief notice of the magnetism of the first of the great iron war-ships of the day, the Warrior, and of the disposition of her compasses. There is but little novelty in the arrangement of those on the upper deck, excepting that it has been deemed desirable to furnish two standard compasses, from the unavoidable proximity of the after one to a new feature, which, from the special character of the ship, has been introduced, namely, an iron-cased tower of rather considerable dimensions for holding riflemen, and of sufficient thickness to withstand the fire of heavy ordnance. This tower is placed on the quarter deck, in the neighbourhood of the steering wheel. The magnetic character of the ship, as developed by the two compasses, before the rifle tower was fixed, is quite in accordance with the received principles, as due to the direction of the ship's head, in building, with reference to the magnetic meridian. The foremost compass, which is about one-third of the ship's length from the bow, had, on the 10th of August last, a maximum declination of 16°, and the after compass, which is about one-third of the ship's length from the stern, a maximum declination of 31°, the ship being built within about 3° of the magnetic meridian (head North, 3° east) and the points of no declination consequently at north and south. The declination of the after compass had lessened 6° on the 24th of August, at which time the casing of the iron rifle tower had commenced. But it is not to these points I would chiefly now direct your attention, but to certain necessities, arising from the novel structure of the ship, demanding, in so far as the compasses are concerned, serious attention. In the fighting ships of what may now be termed a past generation, we did not seek for or expect invulnerability. In 1861 we demand nothing less, and "more iron" is the cry. It is clear from these new conditions that one compass at least, on which the ultimate safety of the ship may depend, should be equally protected from the fire of the enemy, in the event, which would most likely happen, of everything standing on the upper deck being swept away by the fire of the enemy. For the management of the Warrior, under this probable contingency, an additional steerage wheel has been fitted within the great armour-protected space on the main deck.

This space, I need scarcely inform you, is cut off from the ends of the vessel by enormous iron bulk heads. We are thus obliged, without reference to choice of position, to place a compass near this steering wheel on the main deck, and surrounded by iron of massive character on every side, and above as well as below. Under these circumstances we could not but expect deviations of a large value, and particularly from the enormous amount of horizontally-placed iron from the two iron decks and their beams, a large quadrantal deviation. From the few observations I have been enabled to make, owing to the constant progress of the fittings, this quadrantal deviation on the main deck is about 10°, nearly trebling in value the quantities I have had to deal with in the other iron ships of the royal navy. It must be familiar to those who have practically dealt with the subject of correcting ship's compasses by the antagonistic influences of magnets and soft iron, that 10° of quadrantal deviation is an enormous amount to deal with, and that the employment of soft iron contractors, which might be usefully employed in the smaller values, becomes open to grave objections for the larger ones. I have adopted, for the Warrior's main deck compasses, the plan therefore alluded to by Mr. A. Smith, namely the compass cards on Mr. Smith's plan, and two compasses so placed close together as to destroy, by their mutual action, this 10° of quadrantal deviation, and correcting the polar magnet, or semicircular deviation, by *one* system of magnets placed in a vertical plane below, and in a central line between, the two compasses, so that both are equally corrected at the same time. At the time of my observations this semicircular deviation was nearly three-and-a-half points, or nearly 40° at the maximum. I venture to hope that we have by this method overcome the more serious difficulties of disembarrassing the unfortunate compass which is now so tortured in its action by the never-ending introduction of iron of all shapes, sizes, and quality around it; but I feel that increasing vigilance is more than ever required in watching the compass under these conditions, and that the subtle agencies of the forces we employ will elude the control of unskilled hands. The greatest difficulties I have experienced in making certain preliminary experiments, and what must happen practically in dealing with large compass deviations, are those due to delicacy of manipulation and workmanship; for example, the lubber lines of the compasses must be placed exactly parallel, and exactly in the fore and aft lines of the ship: the centres of the compasses must be exactly in a line at right angles to the head of the ship; the adjusting magnets must follow the same accuracy of arrangement; and we are thus, day by day, approaching to the necessity of being forced to expend upon an instrument, so common, but so valuable, and which unfortunately seamen in general, and, I may ventute to add, iron ship-builders in particular, often treat so lightly, the same rigid accuracy of fittings and attention that are required with more delicate instruments of the observatory. I may add that within the last few days I have been informed that the steering compasses of La Gloire (the Warrior of France) are placed within a similar rifle tower on the upper deck. I am further informed by M. Darondeau, who holds, with respect to the French imperial navy, a somewhat analogous position to my own in the royal navy of this country, that this is an unadvisable arrangement. In concluding these brief remarks, I cannot but convey to the meeting the deep debt that the seamen of all nations owe to the President for his long and patient investigation, on their behalf, of the management of the mariner's compass under difficulties. To him we are indebted for the first practical rules on the subject, and, however opinions may have varied as to the uses of correcting magnets under the old condition of things, there can be no doubt that, in the case of the Warrior's main-deck compass, this system, in its main features, becomes an absolute necessity.

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 95.]

As we have already seen, all the means that had been adopted for preserving the insulation of telegraph wires under ground or through tunnels had been found, more or less, inefficient, except in cases where the pipes which contained them were saturated with moisture or filled with water. This was an important consideration in favour of the durability of submarine telegraphs, but the preservation from decay

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was only one of the objects to be attained by the protection of the insulated wires of a submarine cable. Gutta percha is an extremely tender material, and is peculiarly liable to injury from the slightest cause. It requires, therefore, to be protected, even in the process of manipulation, and during its transport from place to place. Nothing has been found more effective for the first protection of gutta percha wire, preparatory to any other covering, than wrapping it, immediately after it is made, with an ordinary tape wound spirally about it, the tape being steeped in tar, or some other similar substance, to ensure its preservation and protect it from the air. A submarine line is, moreover, exposed to a very considerable strain during the act of paying it out of the vessel while laying it down in the ocean. It is necessarily subject to much handling during this process, and to a considerable amount of tensile strain, as it has to pass over "drums" through a break, and lastly, over the stern of the vessel into the sea. In heavy weather, the motion of the vessel, as it rises and falls, throws considerable stress on the cable, and in deep water its actual weight becomes the most important element of strain, especially in cases where cables have been paid out in depths of between two and three miles, and when it is remembered that iron wire of the length of little over three miles will barely support itself. The first cable was designed for shallow water, and a covering of iron wire adopted for its protection. The wire was laid on spirally, and the weight of the cable was, by this addition, made so great that it was not found liable to injury from the anchor of any ordinary coasting vessel. As it would evidently have been imprudent to place such a material as iron in immediate contact with gutta percha, the core was first surrounded with a considerable thickness of hemp steeped in Stockholm tar and tallow. This compound was found to have no destructive effect on the gutta percha, and formed a safe material, in which the wire strands became embedded. The result was most successful; it was peculiarly adapted to the circumstances in which it was placed; and no cable has been more durable. Subsequent cables were constructed upon the same plan, and, as long as the circumstances were similar, with similar success. The most important innovation consisted in this, that, instead of laying several insulated wires together in one rope, each was enclosed in a separate cable. Thus, between England and Holland, four separate wires are enclosed in four separate cables. This system was adopted because in shallow water, where so large a number of vessels are constantly passing, the cables were peculiarly liable to being damaged by anchors; and if one or more of the wires were damaged, the constant communication could be kept up by means of the other wires, and repairs were much facilitated by having so light a cable to deal with. These repairs involved the cost of the constant maintenance of a vessel for that purpose, the expenses of which caused the system to be abandoned, and a large and heavy cable (as heavy indeed as it was practicable to make it) has been laid down in lieu of the separate cables It requires considerable power on board a vessel to be able to lift a heavy cable to the surface, and if a small vessel is so unfortunate as to foul her anchor, the anchor is invariably lost; but of course as the position of such a cable is well indicated to navigators, care should be taken to avoid such contingencies. In dealing, however, with great distances and depths of water, heavy cables become impracticable, unless special vessels of enormous size be constructed for conveying and laying the cables. The Atlantic cable, small as it was, and though laid down in two halves, required a ship of no less than 3,200 tons burthen to carry each half. It is evident, therefore, that no vessel could have been found capable of carrying a much heavier cable. It was also thought that in extremely deep water the cable would practically be so completely out of the reach of accident, that any further protection than was necessary for its mere manipulation in laying down was unnecessary; but although in the case of the Atlantic the use of a small cable was perhaps unavoidable, it is a remarkable fact that in almost all cases small cables have been found liable to mishaps, while the heavier a cable has been the greater has been its durability. So long as iron wire is used for covering the cable, the strain occasioned by paying-out in deep water is but little affected by the weight or size of the cable. Wire, however small, will break with its own weight at a length of or about three miles, and an iron rod, however large, also breaks at the same length, the strength being of course in proportion to the area, and therefore in proportion to the weight. In dealing, therefore, with deep sea cables, it is evident that the strain cannot be varied by a change in size of the cable itself, but by the alteration of the specific gravity of the substance employed. An iron cable we have seen breaks with its own weight at three miles in length; but a small gutta percha wire being but of little greater specific gravity than water itself, might be paid out in any depth without any increase of strain. Indeed, one inventor has proposed that for great depths a cable lighter than water should be used, and anchored by weights at a given distance from the bottom, so that all abrasion would be avoided. These considerations led to the abandonment of iron wire, and the adoption of hemp as an external covering. The specific gravity of hemp is little greater than that of water, and consequently no strain occurs with hempen cables, whatever be their length. But the experience with hemp has not been satisfactory. It has been found too weak, after long immersion, to enable cables to be raised from much depth, and has been frequently eaten away by marine animals and injured by marine vegetation; besides which, it is very liable to abrasion from rocks or gravel; and its absolute durability, even when free from these dangers, is very doubtful. In order to increase the strength of the cable for laying or for raising for repairs, and to increase the specific gravity of the cable, the hemp has been combined with iron or steel wires, which have been embedded in it. The union of hemp and steel has been found to give much greater tensile strength than would at first sight appear probable from such a combination.

In all cases in which small wire has been used without other protection, the rapid corrosion of the wire has been a source of great inconvenience. The iron wire in the early cables has generally been galvanized, and its durability has been increased to a moderate extent by this process; but it is by no means a durable article, even with this precaution, and its durability depends on its local position. When covered with sand or mud, provided there be nothing in the mud itself destructive to iron, the wire appears to last a considerable time under water; but in certain localities, where the cable lies upon rocks, exposed to the constant flow of water, or where the mud or sand contains peculiar constituents destructive to iron, a very few months of submersion have completely destroyed the material. To avoid this corrosion the iron has, as we have mentioned above, been coated with hemp, and this again covered with tar or some other protecting material, and its durability has been undoubtedly increased by this process. The portions of the Atlantic cable covered with tarred yarn picked up in Trinity Bay, Newfoundland, were bright and free from rust; in other cases the hemp has been abraded from the wire, the durability of the cable then becomes merely a question of the durability of the hemp or tar covering.

(To be continued.)

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.—Very little on the market, and for which higher prices are asked.

INDIA RUBBER.—Several large parcels have been disposed of for export.

Fine Para	... ...	1s. 9½d.
Java	... ...	1s. 3½d. to 1s. 4d.

Since more firmness is shown by the importers, and higher rates required, consequently many orders are left unexecuted.

January 8, 1862. WM. KIRKMANN.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do B. 7 per cent. till 1862	all	13 to 20	———
20	Do. C. „ „	all	9 to 11	———
Stock	Electric Telegraph . .	100	93 to 95	———
20	Red Sea and India Telegraph	all	18 to 19	———
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	———
1	Do. registered . . .	all	3/8 to 5/8	———
10	Do. „ . . .	all	4 to 6	———
5	United Kingdom Telegraph .	2	1d. par.	———
	Mediterranean Extension Tel.	all	3½ to 4½	———
	Telegraph to India . .	1	¼d. to 18 p.m.	———

Law Intelligence.

OXFORDSHIRE QUARTER SESSIONS, DECEMBER 31.

(Before the Right Hon. JOSEPH HENLEY *and a Bench of Justices.)*

REGINA V. LAMB AND ANOTHER.

IN this case the defendants were indicted under the 37th section of the 24th and 25th Vict., c. 97, for unlawfully and maliciously cutting the wires of the United Kingdom Telegraph Company (limited).

Mr. Tindal Atkinson, specially retained, and Mr. Sawyer appeared for

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the prosecution: Mr. Huddleston, Q.C., and Mr. Staveley Hill, specially retained, and Mr. Harrington, appeared for the defence.

The United Kingdom Telegraph Company, whose wires may be seen meandering along the canals and roads between London and Liverpool and Manchester, are not incorporated under the authority of a private act, but carry their wires wherever they can obtain leave to place their posts. At the place at which the wires were cut upon the occasion in question, a highway, along which the telegraph runs, crosses the Buckinghamshire line, now in the occupation of the London and North-Western Railway Company at a level crossing; the posts at this point are placed at a distance of 80 yards apart on the green sward by the side of the highway, and the wires are carried at a height of 35 feet over the line. The defendants are in the employment of the railway company, and, on the 8th of November, acting under orders from head-quarters, ran a special engine down to the crossing, and superintended the cutting of the wires by some labourers whom they took with them.

Mr. Atkinson, in opening the case for the prosecution, argued that this was one of the cases provided for by the section of the act passed in the last session above referred to, and that malice was to be presumed from the cutting, which he contended was unlawful; that the proper course for the railway company to have pursued, if they thought that the telegraph company had no right to suspend their wires over the line, was to have brought an action for trespass, and not to have abated it themselves in the manner complained of.

The facts of the case were scarcely disputed, and at the conclusion of the evidence for the prosecution, Mr. Huddleston submitted that there was no case to go to the jury of either the "malice" or the "unlawfulness" necessary to support the charge. The learned counsel contended that the property in the soil of a highway is in the owner of the adjoining lands, and he cited several cases to show that the only right which the public have is to pass and repass, and that this "servient tenement" can in no cases be extended against the proprietor of the lands by whom the grant of the easement is presumed to have been made. He also urged upon the authority of a judgment of Lord Abinger, that where a servant does an act under the orders of his master in the exercise of a presumed right he cannot be held to be criminally liable.

Mr. Henley, the chairman, was of opinion that this last-mentioned decision was conclusive upon this point, and that unless the act done by the servant in obedience to his master's orders was not merely a *malum prohibitum*, but also a *malum in se*, the servant could not be brought within the pale of the criminal law; he therefore directed the jury to acquit the defendants.

Correspondence.

THE DEFECTS OF GUTTA PERCHA.

To the Editor of THE ELECTRICIAN.

SIR,—I think it would be very beneficial to the progress of the science and the welfare of your paper, if your correspondents would be a little more explicit in their statement of facts, more elaborate in their details of experiments, and more logical in their deduction from results than they have been hitherto. Without bringing upon the stage every transgressor, I will simply refer to a short paper on "Telegraphic Failures," by "Electrician," inserted in your last.

In the first place, the substance of the communication has no direct or immediate reference to "Telegraphic Failures." It simply deals with the condition of gutta percha, under varying circumstances of exposure, dryness, and moisture. It might with more propriety have been titled the "Defects of Gutta Percha."

In the second place, he informs us that owing to the diversity of opinion as to the failures of submarine cables, he has instituted a series of experiments to discover how far the insulation of gutta percha is affected by the various treatments it undergoes in the course of manufacture, sheathing, and submersion; but unfortunately he has not favoured us with one of the experiments, nor has he even alluded to the results of such trials. Instead of which he treats of gutta percha, after its exposure to light and air, circumstances which occur neither in "manufacture, sheathing, nor submersion."

He next informs us that "gutta percha, as imported, varies as much in its insulating qualities as it does in the amount of impurities." Hence we may naturally conclude that its loss of insulation is due to the presence of such impurities. "Inferior gutta percha dries up rapidly, that is, its insulating sap, or moisture, becomes exhausted by exposure to light and air. Superior or pure gutta preserves its insulating sap or oil much longer." From this we must conclude that the insulating properties of gutta percha are due to the sap, moisture or oil, which the material contains, and that on the evaporation, or exhaustion, of this insulating material, the gutta percha becomes a conductor. But in the very next sentence he says: "When gutta percha is exposed to light and air, the surface becomes oxidised, and a conductor of electricity; *while the interior as it becomes dry, sustains the electric charge for a considerable time;*" a direct contradiction to the previous conclusion, that gutta percha becomes a conductor when dry. That the insulation of gutta percha is due solely to the essential oil it contains, requires further proof before it can receive general adoption; although that the presence of this "sap, moisture, or oil," secures its non-absorptive qualities, admits of no doubt.

The next paragraph: "I have experimented upon gutta percha which has been exposed to air and light for various periods, from one month to two years, with corroborative results," is very vague. Why not give us the details of these experiments, and let us draw our own conclusions from them? One well authenticated experiment is worth a thousand anonymous opinions, or a thousand unsubstantiated statements.

If your correspondents are desirous that their communications should receive attention, let them avoid these errors. No fact should ever be advanced unless it can be substantiated. No opinion should ever be adduced unless its truth can be vouched for by the narration of conclusions, drawn from facts and experiments, or by the quotation of some well known authority. We never shall advance in our science unless these points are attended to. "Electrician's" paper contains much valuable information, but its effect is lost through want of detail and illogical rendering.

There is not a paragraph in it that is not open to the same criticism as I have given above.

Take for instance the following bold assertion:—"The gutta percha of the Malta and Alexandria core appears to be of an inferior kind, and, upon examination, was found full of impurities. It evidently owes its moderate insulating capacity to the layers of Chatterton's compound." Have we not been told, on authority, that this cable is the most perfect that has ever emanated from the Gutta Percha works, and that its insulation is well nigh perfect? How then can we believe "Electrician's" unsubstantiated statement that it is full of impurities, and that its insulation is only moderate? But mark the next sentence, "Should any fault discover itself in the Malta and Alexandria cable, it would be owing to the absorption of the tar and resin by the gutta percha." Not the impurities nor the moderate insulating capacity, but the absorption of tar and resin! It may be so, but until your readers receive some better authority than "Electrician's" bare assertion, they won't believe it. Had "Electrician" been more explicit in his narration of facts, had he favoured us with a detailed account of his experiments, had he been more logical in his reasoning, his paper might have secured the attention the subject desires; as it is I fear it will fall a dead letter.

The subject is an interesting and important one, and requires very careful handling. The supporters of india rubber must prove the defects of gutta percha before they can secure the use of their material. This has not yet been done, and gutta percha pursues the even tenor of its way.

January 1, 1862. P. Q.

ON FALSE DISCHARGE.

To the Editor of THE ELECTRICIAN.

SIR,—I cannot at all agree with the remarks of your correspondent "Investigator," inserted in your last impression. Their tone is not such as should be received in any scientific discussion. We are all fellow labourers in the same field. We are all striving to advance our profession, and perfect the science upon which it is based. Every one is liable to error, but no one's efforts should be pooh poohed with an anonymous sneer, more particularly so when that person's labours are countenanced and confirmed by the esteemed and deservedly respected name of W. Thomson. I hope the discussions in this paper will be characterized by that courtesy and gentlemanly feeling which should ever distinguish scientific investigation and physical research.

The cause of the "*so called* false discharges" has *not* been satisfactorily and conclusively determined, as your correspondent would have it. Professor Thomson attributes it to one, Professor Wheatstone to another, and a very different cause. How then, when such learned philosophers disagree, can the phenomenon be said to be fully determined? My object is to prove that Thomson is right and Wheatstone wrong.

Mr. F. C. Webb was the first to observe the peculiar currents termed "false discharges," and they are known to this day as "Webb's currents." He published his observations in a very able paper, in the *Engineer*, Aug. 26, 1859. He referred to the fact that had been previously known, that the retardation of signals in a coiled cable was greater than it was in the same cable when laid down. He pretty well described the effects of charge and discharge, and showed how, when a cable was coiled, the true discharge merged into a false discharge. The false discharge current was much more powerful than the true discharge. It was of an opposite kind, and its effect was attributed by him to the induction which takes place between the proximate convolutions of the conductor, the whole coil forming, as it were, a huge induction coil. This conclusion was confirmed by similar effects being produced from an induction coil itself. The phenomena are very ably described, and the letter desires more attention than it has received.

Prof. W. Thomson subsequently (September, 1859) read a paper at the Aberdeen meeting of the British Association, confirming Mr. Webb's conclusions, by the narration of similar experiments, conducted by Mr. Jenkin at Birkenhead.

The subject was carefully studied by most of our electricians, and the views of Webb and Thomson fully confirmed and accepted, but to the somewhat great surprise of the telegraph world, on the appearance of the Government Report, it was found that Professor Wheatstone had taken quite an opposite view of the subject, and had attributed the well known effects of false discharge, not to dynamic induction, but to what are generally termed "currents of polarization."

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Dr. Carl, of Munich, experimenting upon some buried metal plates, also attributed the phenomena of false discharge to electro-polarization (*Phil. Mag.*, May, 1861).

To refute these conclusions, and enable the phenomena to be more clearly comprehended, Mr. Jenkin reinvestigated the matter, and Professor Thomson and he jointly furnished a paper to the *Phil. Mag.*, September, 1861, which is not only compiled with great care, but exhibits all the qualities that should characterize physical research.

The question at issue is, do false discharges result from dynamic induction, or from electro-polarization? I contend that they cannot possibly result from currents of polarization, because the phenomenon is of a totally different nature; and that they must result from dynamic induction, because all their effects can be produced by induction coils, and are in no way contrary to such inductive actions. Indeed they cannot be otherwise accounted for.

First, currents of polarization are totally different phenomena to false discharges. 1. False discharges are highly energetic. They overpower the true discharge. Their tension can be made nearly equal to the primary battery (72 cells), as in Jenkin's experiments. On the contrary, currents of polarization are very weak. They rarely equal the tension of one cell. Wheatstone himself says (*vide* Report): "The electromotive force of the currents, arising from polarization, can never exceed that of one or two cells of a voltaic battery." 2. They are both currents of duration, but the one (false discharge), increases in duration as the length of wire is increased, and the other diminishes under the same circumstances. 8. The direction of false discharge is *always* in the *same* direction as the primary currents. Currents of polarization are *always* in the *reverse* direction. 4. False discharge can never be produced unless the wire experimented upon is coiled. Currents of polarization can be produced on the shortest lengths of wire, coiled or uncoiled. 5. It is not essential that the earth be used to produce false discharge. A return wire may be employed. The use of the earth is essential to currents of polarization; moreover that earth must be moist (see De la Rive, vol. ii.). 6. False discharges are never observed on straight lines of telegraph, submerged or otherwise. Currents of polarization are, however, always observed when broken cables have their ends exposed in the sea.* Currents of polarization are therefore totally different phenomena to false discharge. They are due to the deposition of gas on the buried metal plates, by electrolytic action, and are fully investigated in De la Rive's admirable volumes. They are in no way similar to false discharges, which are purely inductive effects, arising from the proximity of continuous folds of wire, increasing with the number of folds, or the length of the wire, and with the battery power employed. They correspond precisely to Faraday's experiment of the induction of a current upon itself, and in every respect fully conform to the view that has been hitherto, and must continue to be, accepted of their explanation. It is difficult to understand how the learned professor has confused the two phenomena. It may be that he never had a sufficient length of wire, properly coiled under his commands, to produce such effects. He certainly had not at the Government experiments. However it may be, I am quite sure that he is perfectly willing to admit his error, and to confirm the conclusions arrived at by his learned brother in the north.

January 6, 1862. W. H. P.

OCEAN TELEGRAPHY.

To the Editor of THE ELECTRICIAN.

SIR,—One cannot help noticing the universality of the feeling, expressed and unexpressed—the all-absorbing feeling of regret, that we have no telegraphic communication with the Western Hemisphere.

At the present unhappy state of affairs, it would have saved the Yankees from some mischievous, if not fatal, mistakes; and ourselves from a vast amount of anxiety and painful suspense, to say nothing of the pecuniary saving to the country.

Far seeing and intelligent men look upon the general introduction of a rapid intercommunication of ideas by means of telegraphy as the prime agent in abolishing that last miserable vestige of barbarism—war.

If we are forced into war in the present instance, is it too much to say that this worst of all contingencies might have been saved to us, had an Atlantic telegraph been in existence? And the question, why is it not? is no unreasonable one. The fact of a cable having been laid at all, sets at rest for ever all doubts as to its feasibility in that respect; for notwithstanding its failure, it was a real success—a great achievement—a mighty step forward; and in fact more was accomplished than some of the most sensible of telegraphists dared to hope for: sufficient indeed to have warranted the Government in immediately taking advantage of the experience thus acquired, and expending a few hundred thousands in a second attempt.

For what with caoutchouc as an insulator—having the testimony of the highest scientific and electrical authorities as being far superior to all other materials hitherto used as insulating media—especially in its pure state; capable of withstanding the heat of any known climate, and possessing a flexibility and durability eminently adapting it for the core of submarine cables, with the additional advantages of improved manipulation and application to the conductor, we are in a far better position now than heretofore. Add to this the recent improvements in the manufacture of the outer covering of submarine cables, whereby an equal amount of strength, durability, and *more* effectual protection of the core is secured at about a fourth of the weight, and one-half the cost of the old Atlantic cable. With all these advantages, I say, and the accumulated experience (purchased at not too dear a rate) of past failures, and the rapid strides made of late in electrical science and improved manufacture—what hinders, what has hindered, the accomplishment of this great desideratum, which, had it been in being, might have been the means of nipping this unpleasantness in the bud, which, like all such matters, is less likely to terminate amicably the longer it is held in abeyance, from whatever cause.

The whirling away of the first Eddystone light-house by the maddened fury of the ocean, did not prevent another being constructed, which should set enraged Neptune at defiance.

No sensible man looks upon an effectual Atlantic cable as a chimera; rather it is esteemed an absolute certainty—but when?

Truly it were less unwise to spend half a million on such an important work at the right time, than, by delaying its accomplishment, (from a short-sighted economy, or what not,) involve a future outlay of ten, perhaps twenty times, the amount.

When the next mighty convulsion occurs, disrupting great nations, and changing the geography of perhaps half the world, and the eddying whirlpool draws us within the outer circle of the strife, shall we still be unprepared in this respect, as we now are?

But I must apologise for having trespassed thus far upon your space.—I am, &c., A MUCH INTERESTED READER OF THE ELECTRICIAN.

2nd January, 1862.

AERIAL INSULATORS.

To the Editor of THE ELECTRICIAN.

SIR,—Can you or any of your readers inform me of the best shaped insulators for telegraph wires suspended above towns, where the insulators are exposed to smoke, soot, &c., and which rapidly accumulate upon their surfaces &c. Most of the insulators I have seen have large and shelving surfaces, and are therefore ill adapted for the purpose. The smoke also fills the inverted cup with soot, which with that deposited externally affords a ready passage for the current to escape. I have long been of opinion that our insulators are shaped upon a wrong principle, and I hope the hint will not be lost sight of by those more conversant than I am with the requirements of electrical insulation.—Yours &c.

Glasgow. MECHANIC.

GUTTA PERCHA AS AN INSULATOR.

To the Editor of THE ELECTRICIAN.

SIR,—I have recently been informed that the submarine cables laid down for the Electric, and International, and Submarine Telegraph Companies, although having now been submerged for several years, are all in excellent working condition, and have never failed in their insulation, except when injured by anchors or abrasions, &c. The fact should be made known, especially when an attempt is made to cry down the merits of an old friend. Is it generous, or is it just to attribute to an old friend the calamities which have befallen ocean telegraphy within the last few years? I think not. OLD GUTTA.

THE PHENOMENA OF TELEGRAPHY.

To the Editor of THE ELECTRICIAN.

SIR,—Your correspondent "Investigator" whose letter appeared in your last number, has rendered essential service to the cause of telegraphy, by directing attention to the efforts which are being made to thwart its advancement by involving the study of electrical science in needless and incomprehensible abstruseness. While I trust that your columns will be always open to the discussion of useful philosophical and mathematical questions, I hope that you will afford the same opportunity for discussion to those who have gained their information from long observation and practical experience in the operations of telegraphy.

It is rather remarkable that submarine cables laid under the directions of the self-taught Brindleys and Stephensons of telegraphy, have proved eminently successful, while those entrusted to philosophy and mathematical acquirements have mostly failed. Our engine-driver is seldom a philosopher, much less is he a mathematician, nevertheless he is a practical man, and is well up to his duties. To men so qualified, we might safely entrust the manufacture, testing, and submersion of our telegraphic cables, of course under the superintendence of a responsible and experienced telegraph engineer and electrician, not prone to prate in "equations" or indulge in "logarithms" in regulating and directing the duties of his staff. Some of our telegraph manufacturers and contractors have experienced the advantages to be derived from an organized staff, endowed with plain good common sense, and a practical knowledge of the duties assigned thereunto.

Another peculiar feature in the history of modern telegraphy, is the want of unanimity and of co-operation among those engaged in its development. Manufacturers differ, contractors litigate, engineers and electricians run riot. Gutta percha reproaches india rubber, and cries "treacle;" the latter retaliates and hints at "air holes, cavities, impurities, and eccentricity," while the Commonwealth, an unwilling witness to the fray, is condemned to inactivity, and *to pay!*

THE PIPER.

* I adduce these facts from direct experiment, which have been also confirmed by Thomson Jenkin, Webb, Varley, Clark, &c. The details of the experiments would occupy too much space.

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Miscellanea.

POROUS DIAPHRAGMS.—In the year 1838 the use of porous vessels in voltaic arrangements was thus referred to by Andrew Crosse. "For upwards of two years past I have found it convenient in the formation of crystalline and other matters, by the electric agency, to make use of porous earthern pots, of the same nature as garden pots; but without an aperture in the bottom. One of these being filled with a compound fluid, A and B, and being plunged in a basin filled with another compound fluid, C and D; A of the one fluid having a greater chemical affinity (as it is called) to C of the other fluid, than it has to B, with which it is united, and also B to D, so that by the admixture of the two fluids, double decomposition would take place; an electric current being passed by means of primary conductors proceeding from the poles of a voltaic battery in constant action, from one fluid to the other, through the pores of the pot employed, a slow union of A and C, or B and D, or both, takes place, either at the positive or negative pole, or on the inside or outside, or *within the substance* of the pot itself; or in more than one, or in all of these, according to the *nature* and *temperature* of the fluids employed, the *intensity* or *quantity* of the electric current, the thickness of the pots, and the presence or *absence of light*, which last is in most cases of greater or less importance, and in some absolutely essential. The result of this union is common to the production of regularly or irregularly formed crystalline matters more or less firmly adhering to the substance upon which or within which they are formed. I have used these pots in hundreds of experiments, in an infinite variety of applications, and with considerable success. I have likewise used them more or less extensively in the place of bladder in sustaining voltaic batteries, for which purpose they are admirably suited. They have, however, one defect. If, while sulphate of copper is used for the negative cells, a neutral salt be employed for the positive, in the course of time crystallizations are formed within the substances of the earthenware which separates the two fluids, and the pots are cracked in all sorts of forms—sometimes longitudinally; sometimes laterally; sometimes in concentric layers, the outer or inner portions scaling off like the bark of a tree; and sometimes in small angular or circular fragments which start off with a slight explosion, so that after some months' action the earthen vessel is spotted over with deep indentions either external or internal, or both. It is therefore safer and better on all accounts to avoid the use of neutral salts in the positive cells, which I commonly fill with simple water, when I wish to keep up a uniform action for a considerable time, and when I employ these pots merely in the place of bladder."

PROPOSED MONUMENT TO SIR HUMPHREY DAVY AT PENZANCE.—A committee of working men, which has recently been formed for the purpose of erecting a monument at Penzance to Sir Humphrey Davy, have received eight designs from eminent architects, of which those of Messrs. Salter and Perrow have been selected. Those designs are two in number; a monumental column surmounted by a bronze statue 10 feet in height; and a monumental tower, with an internal staircase, and surmounted by the same figure—the height of the monument, from the base to the summit, to be 120 feet in either case. The column, which is the more elegant structure, is simple and beautiful; it has a square solid block for its base, on which are four entablatures; on this base rests a fluted portion of the pillar, some 20 feet long; on this rises a simple column, relieved by polished granite bands, some 40 feet higher, surmounted by a square capital projecting over the column, and relieved by moulding; on this rises a super-base, on which the figure of Sir Humphrey Davy is fixed, with the safety-lamp in his right hand. The entablatures at the base are to have suitable inscriptions, heraldic devices, &c., engraved upon them; also the Davy lamp, the Leyden jar, a gas receiver, and a galvanic battery, are to be placed on the top of four pedestals at the base of the column. The tower proposed is a quadrilateral figure resting on a magnificent Gothic base, with the Davy arms cut in relief over the doorway, which leads to the top of the tower by a spiral staircase, lighted from without from bottom to top. Under the super-base, on which the figure rests, is an outside gallery accessible by the staircase, and immediately under the gallery is a landing with a three-light window, and tracery on each side, to serve as a pleasant "look out." The monument is proposed to be placed on Lescudjack-hill, and it is considered that the summit will be higher than the top of St. Michael's Mount. The estimated cost of the monument cannot be less than £2,500, and if the tower be chosen in preference to the column, some £500 more will be required.

MAGNETIC INTENSITY.—The magnetic intensity is greatest at the poles; the ratio may roughly be said to be 1·3, but more accurately 1 to 2·906. This is found by observation of the oscillations of a vertical or horizontal needle. A needle which made 245 oscillations in ten minutes at Paris, made only 211 at 7° 1′ south lat. in Peru. The intensity and variations which it is subject is strictly noted at all the magnetic observatories, the disturbances of intensity which sometimes occur have been found to be simultaneous by a comparison of observations at different latitudes.

A LECTURE on "The Physics of Imponderable Matter, including the leading phenomena of Magnetism and Electro-Magnetism" was delivered on Monday last at the London Institution, Finsbury Circus, by the Rev. A. Bath Power. The subject is to be continued in two further lectures, to be delivered on the evenings of January 13, and January 20 next.

FROM the observations of M. Berigny, president of the French Meteorological Society, it appears that the proportion of atmospheric ozone increases during the prevalence of the aurora borealis.

A PROSPECTUS has been issued of the London and South of Ireland Direct Telegraph Company, with a capital of £100,000 in £10 shares. The line will cross from Milford to Wexford, Cork, and Queenstown, and the company have obtained an exclusive concession for a station at Roche's Point, at the entrance to Cork harbour, where the pilots reside, and whence they board the steamers, thus enabling telegrams to be sent so as to reach London a considerable time before the mail tender can arrive at Queenstown. The submarine cable is to be constructed by Messrs. S. W. Silver and Co., under their patent for india rubber, which was declared by the late Government Committee on Submarine Telegraphs to surpass all other materials in the principal qualities essential to such works. The whole line will, it is said, be ready for use early in the spring, and its maintenance will be guaranteed by the contractors.

To Correspondents.

ENQUIRER writes:—"Railroads, bridges, steamships, &c., are thoroughly examined by officers under the Board of Trade, previously to their being used for the purpose of traffic, &c., and their reports are made public, but our submarine cables, for which the public have had to pay enormous sums, are not subjected to the same very necessary test under the supervision of a properly qualified officer belonging to a responsible department.

T. M. B.—Nitric acid, of specific gravity 1·45, does not act upon iron under ordinary circumstances, the metal assuming what is termed the *passive state*. The acid of 1·35 sp. gr. dissolves iron rapidly, unless the metal has been previously in contact with the stronger acid. Iron which is undergoing solution in nitric acid of 1·35 sp. gr. may be rendered passive by bringing into contact with it, under the acid, a piece of platinum, or plumbago. The strongest acid should be used for the Maynooth battery.

MECHANIC.—Mr. Bain prepared the solution for the paper used in his electro-chemical receiving instruments by adding nitric acid to a solution of ferrocyanide of potassium until the colour becomes of a dark green, subsequently adding hydrochloric acid until the fluid becomes colourless. The paper immersed in this solution must be used before it becomes quite dry. The following recipe for a solution, which answers the same purpose, and also preserves the paper in a moist condition, is given by M. Pouget Maissonneuve:—

Water	100 parts
Nitrate of ammonia in crystals	150 „
Ferrocyanide of potassium	5 „

O.—The first capital of the Atlantic Telegraph Company was £350,000, in shares of £100 each. Mr. Saward, the secretary, supplies the following information, in his evidence before the Committee on Submarine Telegraphs. "The actual cash outlay has been £387,000, and the capital in addition to that consists of another sum of £75,000, which arises in this way:—The first arrangement made between the projectors and the Atlantic Telegraph Company, and which was entered into before the present board was elected, was that they should receive nothing in the form of remuneration until the cable was laid and successfully at work; and further, until the cable so laid had earned 10 per cent. of dividend to the shareholders; after that 10 per cent. had been earned, the projectors were then to have a right to a moiety of all the balance of profit remaining beyond that 10 per cent.; but although that looked a very fair arrangement upon the face of it, yet, when I came to look thoroughly into the agreement after my appointment, I found it was so hampered with conditions, that really the projectors were the masters of the company. They were to interfere in everything; one could not raise a shilling of extra capital without their consent. They were to have continual supervision of the books, and to dictate what was to go to capital, and what was to go to revenue; and therefore the attention of the directors was very early called to the desirability of getting rid of this agreement by compounding, if possible, for a present payment. This was attempted at that time; but previously to the failure, the projectors were so sanguine as to their prospects under this agreement, that they would not come to anything like a reasonable arrangement. After the failure, however, in 1857, and intermediately between that time and the attempts in 1858, they were, after a great deal of discussion, induced to compromise their chance for a sum of £75,000, to be paid in shares of the company, which shares were not to be disposed of until the cable was laid and successfully at work. "Successfully at work" has been interpreted by the company and by three of the projectors as meaning a proper cable laid and continuing to work, and they have not parted with a single share; but another of the projectors has interpreted it differently, and has thrown his shares upon the public. I ought to mention that that projector is Mr. Whitehouse, otherwise the statement may be thought to refer to others."

LATIMER CLARK.—Too late for this week; THE ELECTRICIAN is sent to machine on Wednesday evening.

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The Electrician.

VOL. I. No. 11.—JANUARY 17, 1862.

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ELECTRICAL PERTURBATIONS IN TELEGRAPH WIRES.

THE discussion of the various conditions which in long telegraph lines, and especially in submarine wires, may interfere with the normal condition of a linear conductor, has necessarily assumed a certain degree of technicality; and to the general scientific reader the points which are actually in question may occasionally seem by no means clear. We propose, therefore, without attempting to dispose of so important and complicated a subject, to offer a few observations, which may enable some of our readers to obtain an insight into the general nature of telegraphic perturbations.

The return current, or *true discharge* of a wire is the simplest of the phenomena in question, as it results from causes which are well understood. It is, in fact, the flow of electricity which has been accumulated in a static form upon the coatings of the Leyden condenser, which is formed by the insulated wire and the fluid conductor immediately surrounding it. In the charging of the wire, an operation which is necessary before a signal can be transmitted, we have the converse of the return current. In point of practice the inconvenience resulting from the discharge of the wire can only be remedied by reducing the speed of transmission; though it may be diminished to a considerable extent by facilitating the discharge of the wire to earth, or by neutralizing its charge by means of a weak battery current.

The return current occurs in a direction opposite to that of the battery current which effects the charge of the wire, and occasions the transmission of the signal. Occasionally, however, the needle of a galvanometer indicates the presence of further disturbing influences of great power. Among these we do not include the perturbations generally known as *earth currents;* under which term have been generally included spontaneous currents occasioned by a variety of causes. According to Dr. LAMONT, "the (accidental) currents observed in telegraph lines are due partly to the agency of chemical causes, partly to thermal causes, and partly to terrestial electricity." But these accidental currents are by no means the most important of the disturbing influences to which we now refer. The perturbations which follow the charge of, and current through the wire, and which are to be referred principally to the effects of electro-polarization and dynamic induction, are probably of much greater practical moment. Next in importance is the action due to chemical causes, which takes place between the earth plates, acting as voltaic elements; or between earth plates and portions of the metallic circuit. This action is, in fact, constant or permanent; though it may easily be neutralized or increased by other disturbing influences.

Turning our attention, in the first place, to the effects of dynamic induction, we cannot but perceive that in the case of an insulated wire, covered externally by a series of longitudinal conductors, supposing these to be insulated, or partly insulated, these effects may become manifested to a very considerable extent. Thus the passage of the current, through the interior conductor, induces in the external wires a current in the same direction, which, in its turn, may occasion a retardation, or rather a prolongation, of the primary current. At the same time it may serve to neutralize, to a greater or less extent, the true discharge of the cable. The phenomenon of the "induction of a wire upon itself," is also obviated in submarine cables by the induction of secondary currents; and it is at the present moment doubtful whether the action of these currents in the external armature of a submarine cable is detrimental or otherwise to its efficient working. The same effects of dynamic induction occur in overland wires when several of these, as is generally the case, are suspended at a short distance from each other; and the induced current in the secondary wire is occasionally sufficiently powerful to produce a signal, which, in the absence of explanation, might be referred to an "earth current."

We consider that the term "false discharge" is applicable to every current occasioned in a telegraphic wire by the effect of dynamic induction. It has been erroneously assumed that such a current cannot be produced unless the wire under experiment be in the form of a coil. But the false discharge, neutralizing and overpowering the true discharge, is a constant phenomenon of voltaic conduction. This same induced secondary current, occurring in the same wire as the primary current, is the cause of the true discharge not becoming evidenced in circuits of moderate length. If we connect the elements of a voltaic couple by means of a short wire, and make and break circuit in a cup containing mercury, no spark, or but a very minute one, will be perceived. This spark, occasioned by breaking the battery circuit, and conveniently exhibited by means of the mercury, is, we know, dependent upon an inductive action in the wire, producing an effect the moment the current is stopped. Thus if we arrange our short wire in the form of a coil, in which the inductive effect may be aided by the mutual action upon each other of the several convolutions, this effect, and the resulting "voltaic spark" will be greatly augmented. But they can also be augmented by simply increasing the length of the conductor, until, in the words of Professor Faraday, "from its extreme length, the resistance offered by the metal as a conductor begins to interfere with the principal result." It must, we think, be admitted that in every case the action which takes place in a telegraph wire, when contact is made and broken with the battery at one end; the other being in contact with the earth, is as follows:—

1st. When contact is made. A flow of electricity assuming a static character first occurs from the battery along the wire. When the wire has become charged, the electricity traverses it in a dynamic form.

2nd. When battery contact is broken. The primary dynamic action instantaneously ceases; but an induced secondary current along the wire, in the same direction as the former current, is brought into play, which may occasionally be rendered evident if the line be brought to earth at the transmitting station immediately after the battery contact is broken. At the same moment the true or static discharge of the wire takes place in a contrary direction, in most cases practically neutralizing, and becoming to some extent neutralized by, the induction current.

But in very long overland wires, in which the static charge is small when compared with that of a submarine cable; the induction current or false discharge, as observed by Gavarret, overpowers the true discharge, and may consequently be observed upon the galvanometer when the line wire is connected alternately with the pole of a battery, and with earth. The same effect occurs in a greater degree when the conducting wire is arranged in the form of a coil, as in the experiments of Mr. F. C. WEBB, by means of which so much attention has been drawn to the phenomena of false discharge.

In the same class as the non-accidental causes of perturbation to which we have referred, must be placed the polarization of

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earth plates, and of imperfectly insulated portions of the metallic circuit. Currents arising from this cause probably interfere to a very great extent with those to which we have already referred. The tension of such currents may n most instances be very small; but their action is perhaps to be explained by the fact of their possessing considerable quantity, and being thus able to exert a powerful neutralizing effect upon the current which occasions the phenomenon of false discharge and, as we have seen, obviates in most instances that of the true discharge.

It is to be regretted that comparatively little information on this important subject is to be gathered from the experiments on true and apparent discharges detailed in the Government Report. These experiments certainly appear insufficient to negative the conclusions which had been previously arrived at; though they may show that we are far from having obtained a complete insight into the various disturbing influences which interfere with the rapid transmission of signals in lines of considerable length.

SUBMARINE TELEGRAPHY.

OF a truth we cannot at this present moment complain of a dearth of enterprise in submarine telegraphy! In one of our earlier numbers it was observed by an able writer on financial subjects that "a state of ease in the money market is supposed to indicate that an era of speculation may not be far distant." This era would appear to have come, and to have peculiarly favoured telegraphic enterprise. It would have been difficult to foresee the nature of the events which have thus stimulated activity and encouraged investment in this channel. A disruption with America has occurred, during which the absence of a means of telegraphic communication between Europe and the New World was regarded throughout England almost in the light of a calamity which might have been avoided. The subject of submarine telegraphy was thus brought prominently and favourably into public notice, and time was ripe for the announcement of projects which were already based upon securer grounds than a temporary enthusiasm in favour of the electric wire. An offer is first made by an eminent firm of telegraph contractors to construct, lay, and guarantee for one year an efficient cable across the Atlantic. Her Majesty's Government thought fit to decline this offer, which unfortunately came too late to arrest the necessity for the expenditure of some two millions sterling, which it has cost the country to prepare for the contingency of a struggle with the Northern States of America. Next was made public a proposal to unite by submarine lines the West India Islands, an enterprise of fair promise, which, if realized, will no doubt prove beneficial to those Islands, and remunerative to the shareholders. Then we learn that a company has been formed to establish a much needed line of telegraph between London and the south of Ireland, and that this company, of which the direction is unexceptional, have secured the services of no less an authority than PROFESSOR WHEATSTONE, F.R.S., as scientific referee in endeavouring to make this line the most perfect of its kind. It appears, however, that the present "era" is yet more prolific, and promises even a redundancy of telegraphic enterprise. The St. David's Head and Wexford Telegraph Company (limited) has been announced with the same object in view as the company to which we last referred, viz., the London and South of Ireland direct Telegraph Company (limited). There is obviously here a superabundance of endeavour in one direction; and we should be sorry to see an unnecessary and wasteful competition in the matter of establishing direct telegraphic communication with the south of Ireland; while many other equally important and useful prospective schemes remain in abeyance. The St. David's Head and Wexford Telegraph Company have come forward, *mais un peu tard*, in a field of enterprise, which, in this direction, is already fully occupied; and their chances of success, at least in a pecuniary point of view, appear therefore problematical. In this instance competition, which is generally to the advantage of the public, could only have an unfavourable effect upon the extension of telegraphic communication.

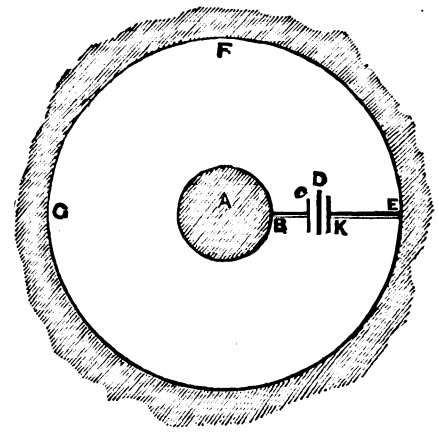
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 111.]

WHEN the two sides of a source of generation are completely separated by a substance offering practically infinite resistance, no recombination can occur, and consequently no generation, can take place, except through conditions for accumulation on each side of the source.

These conditions for accumulation obtain through what is termed inductive action, in varied form; and may be thus illustrated. Suppose A to represent the section of a spherical conductor, joined by a conductor B C to one side C, of a source of generation D, whilst the other side, K, is joined by a conductor K E



to a hollow spherical conductor E F G, concentric with A, and separated from the conductor A, in every direction, by a non-conducting medium, or dielectric, such as glass or air. On such an arrangement being established, certain equal quantities of electricity would, in a minute portion of time, be generated at each side of the source, and be accumulated at the surface of junction of each conductor with the intervening dielectric, after which all action would practically cease.

Strictly speaking, when the dielectric is a solid, the electricity is resident on the dielectric, but for convenience it is easier in explanation to speak of it as on the surface of the conductors. Even in the case of a solid conductor, surrounded by air, it is doubtful whether it is absolutely correct to say that the electricity is resident on the surface of the conductor, although, when we move a charged conductor, we certainly carry the electricity with it. For, if we consider electricity simply as a polarized state of the dielectric, terminating at the surface of junction with the apparently charged conductor, we can conceive the polarized particles continually changing (as we move the conductor through the air), but always replaced by fresh particles to which the former transpose their electric or polarized state, at the same moment that the change of the particles themselves take place.

In the present state of our knowledge it appears, however, sufficiently correct for the purposes of this essay to assume that the surface of the conductor is the charged surface.

The electricity on the sphere A would be of an opposite nature to that accumulated on the conducting and opposing surface G F E, but the quantities would be exactly equal.

This accumulation is termed a static charge, and the degree of accumulation or *quantity accumulated on a given area* is termed the *density*, though by some writers the term *tension* has been applied, erroneously, however, as I shall show further on.

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From the form of the two conducting surfaces, and their relative position; the density of charge on every part of A would be similar, whilst the density on the outer surface would also be uniform throughout. Since, however, we have in the two cases equal quantities distributed over unequal surfaces, the densities on the two would be unequal, being greatest on the smaller surface A.

The result thus described is similar to that obtained in the ordinary case of charging the prime conductor of a frictional machine, when the rubber is connected to the surrounding objects, or in fact to earth.

On establishing the system, the surface of the conductor becomes charged with a certain quantity of electricity of a name dependent on the pole to which it is connected, whilst the surrounding conducting objects, such as the walls, ceiling, furniture, and floor of the room, will have an exactly equal quantity of electricity of opposite name, distributed (though not in this case *equally*), over their surface.

The action which maintains the two charges in this strained state on the opposing surfaces of the separating dielectric medium, is attributed by Professor Faraday to an action taking place through the particles of the medium itself, by which each particle is polarized, and reacts not only on its contiguous particle in one direction, but in several directions. It is not my purpose to enter into these more delicate and complicated details of hypothesis. It is sufficient for the purpose of this essay to assume that in the action causing two conducting surfaces in connection with the opposite sides of a source to become charged, the tendency of the separated electricity to recombine (however that action be produced), first determines them to, and then maintains them *on* the opposing surfaces, until disturbed by fresh conditions, by which they are forced either to recombination and neutralization, or to an altered state of distribution, and it is an attempt to investigate the general principles which govern these effects which forms the subject of the earlier part of this essay.

The position that I have advanced, viz., that the electricity generated at that side of the source in connection with earth is as much conducted to, and distributed over the adjacent opposing conducting surfaces, as the other electricity is spread over the insulated conductor, and that thus the outer opposing surface is in every respect as much a charged surface as the prime conductor, the difference being only one of degree—is, I am aware, contrary to all published explanations of the action that takes place, and I shall therefore digress to discuss this view.

Most writers assume that when the one pole of a source is connected to earth, the electricity generated at that pole is "spread over the indefinitely large surface of the earth, and virtually annihilated."

I shall here quote a few passages to show that in the explanation given in most works, the size of the earth is always recognised as the all important element in the theory.

Thus Professor Daniell ("Chemical Philosophy," p. 241), after describing the effects that would take place when the rubber of an electrical machine is unconnected to earth, continues, "but to obtain the highest effect from either (*i. e.* rubber or prime conductor), it is necessary to make a good conducting communication from the other to the ground. The reason of this is, that when the two electricities are in presence of each other they counteract and limit each other's intensity; by connecting either conductor with the earth its charge is spread over an *indefinitely large surface* (*i. e.* of the earth), *and virtually annihilated.*"

Again: Sir W. Snow Harris ("Rudimentary Electricity," p. 69), in describing the theory of the frictional machine, according to the double fluid theory, observes: "Very little effect is produced so long as the positive and negative conductors remain insulated. Directly, however, we connect one of these conductors with the ground, the other will be in a position to charge any insulated substances presented to it to a point of saturation; for the neutral state of the one conductor becomes restored at the expense of the opposite electricity drawn from the *mass of the earth*, and the insulated body may be considered as being electrified by this operation, the one positively, the other negatively, according to the conductor with which they are associated. But the electricity of the *earth* being indefinitely great, the result is only sensible on the lesser insulated body, and the action is limited to the quantity of positive or negative electricity which it can furnish."

Again: in stating the action according to the single fluid theory, Sir W. Snow Harris (p. 71), after describing the insulated conductors, in connection with the rubber and prime conductor, as giving up electricity from one to the other, he goes on to say:—

"We have still, however, reached a limit depending on the amount of electricity which the respective bodies can yield up or receive. Such is, in fact, the condition of the conductors, one of which receives the excited electricity on the glass, whilst the other yields up electricity to the rubber. When, therefore, we connect one of these conductors with the *earth*, the action may become *indefinitely* great upon any insulated body applied to the other, and required to be electrified, however great its extent, the means of supply of electricity being without assignable limit."

Again: Gavarret (vol. i. p. 67), writes, in describing the electrical machines.

"Lorsque le plateau est mis en rotation, son fluide neutre est decomposé par le frottement des deux paires de coussins, l'électricité positive reste accumule sur le plateau, et la negative se porte sur les coussins d'où elle *s'écoule dans le sol.*"

Again: Messrs. Lardner and Walker write (vol. i. p. 248, "Electricity Magnetism," *Cabinet Cyclopædia*):

"When an electrified conductor is touched by the finger it instantly loses all its electricity. Where, it may be asked, does this electricity escape to? It is easy to show that it passes through the body of the person touching the conductor, and from his body to the earth.

"To demonstrate this, let us first suppose that a pith ball, suspended by a non-conducting thread, is charged with electricity. We have seen that if it be touched by the finger it will immediately lose all its electricity. But, instead of being touched by the finger, let it be brought in contact with another pith ball, of ten times its diameter, also suspended by a non-conducting thread. It will be found that the smaller ball, after the contact will have retained but a small portion of its electricity. In fact, the greater ball, having a diameter ten times greater, has a surface a hundred times greater than the smaller one; and the electricity which, before the contact was confined to the surface of the smaller ball, is diffused, after the contact, by the conducting power of the balls over the surface of both. The greater ball takes a portion of it nearly a hundred times more than is left on the smaller ball, and the electricity remaining on the smaller ball is therefore nearly a hundred times more feeble than it was before the contact.

"It is evident that the degree in which the electricity on the smaller ball is diminished by such means, will depend on the proportion of the surfaces of the two balls; and that, by augmenting the magnitude of the greater, the quantity of electricity left upon the lesser will become insensible.

"If, then an electrified conductor be taken to represent the smaller ball, and the whole globe of the earth the greater, it will be easily perceived that, where such a conductor is made to communicate with the earth by any conducting substance, such as a metallic wire or chain, or the human body, the electricity which was before accumulated on the insulated conductor will be *shared between it and the whole surface of the earth;* and as its surface, however extensive it may be, must be infinitely small compared with that of the *earth*, the electricity remaining on the conductor must be proportionately small compared with what it has lost. In fact the quantity remaining on it is inappreciable, and the conductor may be considered as restored to its natural state.

"As all bodies temporarily electrified must in this manner give

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up their electricity to the earth, the moment that the means taken to insulate them are removed, or whenever they are touched by any conducting substance, or even by the conducting power of the aqueous vapour suspended in the air, the earth is called the *common reservoir* of electricity. *All free electricity, wherever and however confined and accumulated, must return to it.*"

Again, M. De la Rive writes (vol. ii. page 3):—

"Une surface electrisée qui est mise en communication avec le sol, au moyen d'un ou plusieurs conducteurs, doit perdre son electricité; en effet, cette electricité passe dans les corps conducteurs et de là dans le globe terrestre où elle se repand et par consequent devient insensible, vu l'immensité de la masse dans laquelle elle se distribue. Aussi nomme-t'on le globe terrestre le *reservoir commun*, pour indiquer que c'est là que se porte l'electricité des corps qu'on fait communiquer avec lui."

It will be seen from these quotations that, although the explanations they contain are not precisely similar, yet that in the main points they all tend towards regarding the size of the earth as compared with the size of any ordinary conductor, as the primary and essential cause of the apparent disappearance of all electrical excitation, when such conductor is connected to the earth.

Indeed, if we consider these views, as well as others, on the condenser, we must arrive at the conclusion that electricity tends to flow into the earth in all cases when the surface on which it resides is connected to earth.

Electricity is evidently, therefore, here treated as consisting of two elastic fluids, either of which will of itself *alone* flow to, and expand over, *any* conducting surface to which the conductor on which it resides is connected by a conductor.

Now this, of itself, is contrary to the nature of the action exhibited in the most ordinary experiments; for, considering the two opposite states as two fluids, these invariably exhibit a strong tendency in every case to recombine, or else to accumulate themselves most on those parts of the surfaces to which they are connected, which are *separated by the least inductive resistance.*

(*To be continued.*)

INSULATION AND CONSTRUCTION OF SUBMARINE CABLES.—(No. I.)

INSULATION may be justly regarded as one of the most important elements in the construction of submarine telegraph cables, &c. It is necessary to observe, however, in the first instance, that before coating, or covering a conductor with gutta percha, india rubber, or, in fact, any insulating agent, the wire ought to be of the *best quality possible*, in order to give the highest percentage to its conductivity; and when the latter has been obtained, we are then in a position to proceed with the insulating process, with good results, provided a good insulator is used for the purpose.

We may here ask what a good insulator consists of. Take for granted that there are many good insulating materials; but it must be borne in mind that there is a difficulty in applying some of them to the conducting wire, thereby rendering them useless for telegraphic purposes. Hitherto, gutta percha has been exclusively used, also failed to a great extent; often reported upon by the press and the scientific world at large. We may inquire what the results would have been provided india rubber had been used for submarine cables, instead of gutta percha, or the compound known as "Chatterton's!" in spite of its failings. We are too happy to state, however, that the majority of telegraphists have decided in favour of caoutchouc, in consequence of its preserving its high insulating properties at all temperatures to which it might be subjected. This brings us to the conclusion that the gum is specially adapted for insulating telegraph conductors, in preference to any other known agent. A question here suggests itself: How is it to be applied to the wire, in order to obtain the *best* electrical results, also its DURABILITY when submerged in deep sea, or exposed to atmospheric influence? It has been stated that india rubber is liable to decomposition, the cause of which appears as follows:—First, that when any known solvents are incorporated with the gum in the *process of mastication*, and when the ribbons or filaments are moistened with the same, during the process of covering the conductor, the core thus formed submitted to a moist temperature of 140° or 150°, it invariably causes decomposition in a very short space of time, and it is a remarkable fact that wires thus constructed are set forth by Professor Wheatstone, in the Government Report, page 285, as superior to any others, although really in a state of decomposition.

Mr. Latimer Clark says, page 330, Government Report:—"In spite of these high qualities, masticated india rubber wire has some defects which render some caution necessary in its use. One of these defects is the spontaneous decomposition of the caoutchouc. In certain specimens of the wire, the rubber, where it is in contact with the interior copper wire, spontaneously changes into a black viscid treacly-looking fluid, which oozes out at the ends, and leaves the wire to some extent loose in the centre. . . . . The manufacturers of the wire, ascribe it to the use of inferior caoutchouc; but after this opinion was given, a sample which was supplied by the same manufacturers underwent the same change."

The facts were these, that they possessed high insulating properties when compared with gutta percha covered wires of the same diameter, when in such a state; moreover the extra *thickness* of the *dielectric* was *double* to others of the same kind, which were reported upon by the committee.* It is to be regretted, however, that such a statement should have been made to retard the progress of submarine telegraphy, also, to the injury of other manufacturers, who are prepared to insulate telegraph wires with india rubber, which will not deteriorate, even when submitted to high temperatures.

The best known method to prevent decomposition is to submit the gum to a dry temperature, when no fear need be entertained as to its durability. There are manufacturers who prefer this method, and it is an important fact, that in *no instance* have their cores suffered from decomposition. As a proof, we have only to examine the specimens of india rubber covered wires of Messrs. Hall and Wells, which were made three or fours years ago, and are now to be seen at the South Kensington Museum. This being a fact, leads us to the conclusion that your correspondent "Insulator" is not conversant with the manipulation of the gum in question.

SCRUTATOR.

January 14th, 1862.

(*To be continued.*)

ON THE DISCHARGE ON COILED AND UNCOILED INSULATED WIRES.

THE following experiments were made to determine the difference in the amount of inductive discharge in a coiled cable and in the same cable laid down in a straight line.

The coil, in the first experiment, consisted of gutta-percha covered wire 330 feet in length. It was formed into a coil 1 foot in diameter, and then placed in water at a temperature of 60° Fah. A very delicate and reliable galvanometer being employed, and a battery power of 512 elements.

	Discharge.	Mean.
Coiled core	11·7°	11·73°
	11·8	
	11·7	

The core was now uncoiled, and placed in an iron pipe of equal length filled with water, at a temperature of 60° Fah.

	Discharge.	Mean.
Longitudinal core	11·2°	11·02°
	11·1	
	10·9	
	11·0	
	11·1	

* A full description of all the india rubber covered wires, referred to in the report, will be given in a future article.

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The core was again coiled and placed in water, as in the first instance.

	Discharge.	Mean.
Coiled core	11·8°	11·74°
	11·7	
	11·7	
	11·8	
	11·7	

In the second experiment a core of gutta percha covered wire of 97 ft. in length was employed. It was placed in a long wooden trough filled with water at a temperature of 57° Fah.

	Discharge.	Mean.
Longitudinal core	2·5°	2·43°
	2·4	
	2·5	
	2·4	
	2·4	
	2·4	

The core being uncoiled and placed in water as before.

	Discharge.	Mean.
Coiled core	3·0°	3·05°
	3·0	
	3·1	
	3·0	
	3·1	
	3·1	

In the third experiment a core of special gutta percha (an improved material) was employed. Length 330 ft. Laid in a longitudinal iron pipe filled with water (as in the first experiment) at a temperature of 61·5 Fah. A different galvanometer employed, but the same battery power.

	Discharge.	Mean.
Longitudinal core	1·5°	1·48°
	1·5	
	1·5	
	1·4	
	1·5	
	1·5	

The core was withdrawn from the iron pipe, coiled, and placed in water at a temperature of 62° Fah.

	Discharge.	Mean.
Coiled core	1·4°	1·45°
	1·6	
	1·5	
	1·6	
	1·4	
	1·5	

In the fourth experiment, half a mile of india rubber covered wire was employed. It was wound up tightly upon a drum of about 18 inches in diameter, and placed in water. 128 elements employed.

	Discharge.	Mean.
Core wound on drum	8·7°	8·6°
	8·7	
	8·6	
	8·5	
	8·5	
	8·6	

The wire was then unwound off the drum, and laid longitudinally (in parallel lines) in a large water tank of about 30 feet in length.

	Discharge.	Mean.
Core off the drum	8·7°	8·73°
	8·8	
	8·7	
	8·8	
	8·7	
	8·7	

Another length of india rubber covered wire (about half a mile) was tested on the banks of the Regent's Canal by Mr. Latimer Clark, and the writer. The drum was submerged in water, and the measurement of the discharge taken. Number of elements employed, 128.

	Discharge.	Mean.
Core wound up on drum	6·2°	6·37°
	6·3	
	6·4	
	6·5	
	6·4	
	6·3	
	6·4	

The core, on being removed from the drum, was laid down in a straight line along the canal, and again tested.

	Discharge.	Mean.
Core in straight line	6·4°	6·42°
	6·4	
	6·5	
	6·5	
	6·5	
	6·4	
	6·4	
	6·3	

Another core of india rubber covered wire 916 yards in length, wound on a drum, was placed in the canal.

	Discharge.	Mean.
Core on drum	11·7°	11·54°
	11·6	
	11·5	
	11·4	
	11·6	
	11·7	
	11·5	

The same unwound and laid at full length in the canal.

	Discharge.	Mean.
At full length	11·4°	11·61°
	11·4	
	11·6	
	11·7	
	11·8	
	11·6	
	11·8	

Numerous experiments were made from time to time, with a view of determining the cause of the difference in the amount of discharge in coiled and uncoiled cores, and the above are fair specimens of the results. It was always found that in cores of low insulating capacities the discharge on the core, when coiled, was always in excess of that when in a straight line, according to the amount of leakage in that core. With superior insulators the excess of discharge, if any, was in the cable when laid in a straight line.

These phenomena may, to some extent, afford a clue to the cause of "false discharges." Is it not owing to polarization of the copper conductor in inferior insulated cables, when laying in large masses in close proximity to the battery earth plate? O. R.

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 117.]

The most simple and practical way of covering a rope, and that which consequently first suggested itself, was to lay the iron wire spirally on the core; but this method was not free from objections, amongst the greatest of which was the liability of such a rope to form itself into kinks, which depend, to a great extent, on the lay of the spiral covering. These kinks are apt to occur, whenever sufficient slack accumulates to allow them to form. If, in paying out a line, slack be allowed to run overboard whilst the vessel from any cause is laying to, it almost invariably becomes entangled and twisted at the bottom of the sea in the most remarkable manner, especially when there is a strong tide. Or if, in paying out the cable from the hold of a vessel, where it is laid in large carefully-arranged coils, these coils become entangled in the hold, a large quantity of slack is rapidly drawn into the breaks, the paying out suddenly stopped, and the cable sometimes damaged, before the speed of the vessel can be checked. If the ordinary twisted rope could be placed on a drum as it is manufactured, and the drum carried on board ship, and the line paid out directly from the drum into the sea by the rotation of the drum on its axis, no liability to kinking could arise; but such a process is evidently impracticable, the weight of the drum and its coil being far too great to be dealt with by any mechanical means. If such a rope were slipped off the drum, and in this state laid in the hold of the vessel, every coil that was paid out from the mass would throw a "turn" into the outlying rope, and these twists accumulating would rapidly tend to the destruction of the cable, either by untwisting it or tightening it to such a degree as to throw it into kinks. When the cable is laid in the vessel, a turn is laid in with every coil; in paying it out, the reverse operation undoes the turn which has been laid in, in the first instance. It is important to avoid coiling or uncoiling a cable, when finished, more often than is absolutely necessary; and even its transference from the factory to the ship, and from one ship to another, is hazardous. To remedy the inconvenience from kinking

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many devices have been suggested, such as plaiting the hemp or wire on the cable, or laying them in parallel layers, and afterwards binding them all over with a spiral wire. Lines so constructed with parallel wires or strands possess this additional advantage, that in case of great tensile strain the parallel wires tend directly to protect the inner core from strain without in any way increasing the pressure upon it, whereas, if great tension be put on a twisted cable, the elongation of the cable tends to the compression of the inner core, and that to such an extent as sometimes to cause considerable damage. Cables have been thus taken up in which the insulated wire has been greatly reduced in diameter by this tension, and the gutta percha itself nearly destroyed. It also frequently happens, on the relief of this tension, that the contraction of the outer covering and of the gutta percha, causes the copper to knuckle through and come into contact with the strands of iron. Or in other cases, when the cable has been elongated, the core of copper wire covered with gutta percha has been permanently elongated, and forced itself through the strands of iron wire. It is an important consideration in the outer covering of a submarine cable that the delicate insulating material which covers the conductor is liable to numerous injuries during the process of laying on the outer covering, and that although the core may have been originally perfect, these injuries will sooner or later prove the destruction of the cable after it has been laid. The plan which has hitherto been adopted of covering the core with a serving of hemp or tape, saturated with some insulating material, enables any injuries which have occurred during the process of laying on the outer covering to be concealed until after submergence: it has, therefore, been suggested that it would be desirable to saturate the serving of hemp or tape with a conducting material, instead of with a non-conducting material, and to keep the cable in water and under electrical tests during the whole time of manufacture and until submerged. One mode of obtaining these tests would be to stow the cables in defined lengths, in a series of insulated tanks, and to keep a constant current on the cable; the proportion of the current which escapes from each tank would show whether the portion in one tank was worse than that in other tanks. Another method is that which was adopted by Messrs. Simens and Halske, for testing the Malta and Alexandria cable.

We have had laid before us numerous specimens of proposed cables for deep sea lines, as well as a series of experiments upon different forms of cable, made for the Treasury, by Messrs. Gisborne and Forde, for determining the form of the Falmouth and Gibraltar cable.

We have ourselves made experiments upon several forms of cable specially devised by various persons for deep sea lines. The following table gives a general view of the results. As one of the main objects to be attained is a minimum of extension with a maximum of breaking weight during the process of laying, we have compared the results by showing for each cable the equivalent length in water due to a definite elongation and to the breaking weight.

Cables in which the Strength is placed in the Outer Covering, by means of Hemp or Wires, laid on spirally.

Name.	General Description of Arrangements for Strength and Protection.	Specific Gravity.	Length of Cable in Water in Fathoms equivalent to 0·5 per Cent. of Elongation.	Length of Cable in Water in Fathoms equivalent to 1· per Cent. of Elongation.	Length of Cable in Water in Fathoms equivalent to Breaking Strain.
			Fathoms.	Fathoms.	Fathoms.
Clark, L. - - -	Steel wire, with a slight spiral, covered with tape, shellac, and marine glue. *See* Plate, No. 5 - - - - - - - - -	1·92	1,610 1,119	Not reached Not reached	Not broken. 3,376 Not broken.
Gisborne and Forde (Gibraltar Deep Sea).	Steel wires, coated with hemp, laid spirally. *See* Plate, No. 2 - - - - - - - - -	1·9	1,176 2,440	1,947 3,924	Not broken with a weight = 5,683 fathoms in water.
Siemens - - -	Strands of hemp, laid spirally, protected by thin copper sheathing. *See* Plate, No. 4 - - -	1·5	1,342 2,046 1,694	2,552 3,672 3,284	Not broken. Do. Do.

Cables in which the Strength is placed in the Outer Covering, by means of Hemp or Wire, laid on longitudinally.

De Bergue - - -	Tarred hemp lines served round with cord of hemp. *See* Plate, No. 5 - - - - - -	1·26	5,300 —	8,124 5,908	Not broken. 16,982
Godefroy - - -	Steel wires, coated with india rubber, and covered with india rubber canvass. *See* Plate, No. 8.	1·9	2,658	Not reached	3,424
Do. - - -	Do.	1·4	2,596 2,596	3,500 Not reached	Not broken. 3,309
Hall and Wells - -	Hemp lines kept in place by plaited hemp. *See* Plate, No. 4.	1·35	760	1,126	4,420 4 per cent. extension.
Do. - - -	Steel wire and hemp lines kept in place with plaited hemp.	1·6	2,499	Not reached	2,729
Do. - - -	Do. - - - - - - - - - -	1·9	2,437	4,525	5,597
Silver - - -	Steel wires, covered with plaited hemp. *See* Plate, No. 2 - - - - - - - - -	2·8	1,642 1,832	2,260 Not reached	Not broken. 3,213
Sinnock - - -	Tarred hempen lines, served in a close spiral, with hemp string and iron wire. *See* Plate, No. 4	1·4	622 —	1,088 463	Not broken. 2,855
	Do. - - - - - - - - -	1·7	997 —	1,782 636	— 7,132

Cables in which the Strength is placed next the Copper Conductor inside the Insulating Covering.

Allan - - - -	Steel wires laid spirally on copper conductor, outer covering plaited jute, saturated with marine paint. *See* Plate, No. 8.	1·6	1,519 1,283	Not reached 2,258	Not broken. 2,936
Do. - - -	Do., outer covering india rubber canvass.	1·38	3,405	5,555	7,484
Do. - - -	Do., outer covering Godefroy's compound.	1·3	3,885	6,340	6,348

As regards the liability of these cables to kink, we would observe that the Messrs. Gisborne and Forde's (Gibraltar) cable was easy to kink, and was set in the kinks by tension. Messrs. Silver's cable was disposed to kink. Messrs. Clark's, De Bergue's, Godefroy's, Hall and Wells', Sinnock's, and Allan's were difficult to kink, and the kinks generally unfolded by tension.

(To be continued.)

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THE ELECTRIC TELEGRAPH IN RUSSIA.

THE following interesting report, relative to various proposed telegraph routes—some of which are in active course of formation—for establishing telegraphic communication, *viâ* Russia, between Europe and America, China, Japan, and the East Indies, is sufficient to show with what energy the work of telegraphic extension is being pursued in Russia. Important results, more especially to the country which is now endeavouring to render St. Petersburg the telegraphic centre of the world, will doubtless follow from the initiative thus taken.

"The failures of the experiments in submarine telegraphic lines, and the consequent losses attendant on them, are of such a character that their causes deserve minute investigation. In addition to the incomplete examination of the depths and peculiarities of the seas and oceans, and the imperfect mechanical contrivances for that purpose, there are still far greater obstacles to be overcome to enable a complete examination to be made, and to establish telegraphic communication between the different parts of the globe, separated by vast oceans, impenetrable deserts, or barren wilds.

Such an enterprise as that of connecting the Old World with the New, and other parts of the globe, cannot be carried out without great loss of capital and other sacrifices; and even if successful for a time, through the application of some improved contrivance, it would always be very expensive to maintain it in perfect order. The unsuccessful projects of the Atlantic and Rea Sea cables, which have swallowed up nearly £2,000,000, and which enterprises are now considered, by men capable of judging, to be dead failures, yet are not so impracticable as many would seem to believe, provided that a different and safer plan than that hitherto pursued be followed—viz., for the former, the adoption of the route through Russia, where, passing up through the Behring Straits (about 50 miles broad), the Aleutic Islands seem to form the piers of a bridge, shaped out as it were by nature to connect the Old with the New World.

That the eastern route, *viâ* Russia, has already proved of great importance to Europe, is evidenced by the sensation that was excited in 1858 and 1860, when the papers received the telegraphic news, *viâ* Siberia and Russia, of peace having been concluded with China, and yet telegraphy in this part of the world is only in its infancy.

It may also be added that the English and French Ambassadors in China are now using that line for their correspondence, transmitting it from Pekin through Mongolia.

Another fact may be mentioned bearing on this point—viz., that a telegraph company in England has offered several commercial houses in London to transmit their messages to and from the East Indies, through Russia and China, *via* Pekin, which is considered a quicker route than the usual mode of communication, the East Indies being connected by steam navigation with the Chinese ports, which will now be extended from Shanghae to Tien-tsin, on the river Hai-he (Pei-ho).

East Indian messages sent by this route are forwarded to Pekin; those from the latter place are handed over to the Russian Post-office, and transmitted to Kiachta, taking from 11 to 14 days; thence by courier to Kasan, and sent by telegraph thence to London; but as soon as the telegraph line, which this year will be completed to Omsk, shall reach Irkutsk (some time in 1862, European telegrams to or from Pekin will be transmitted in 14 days.

Thus the universally important Siberian line will be a *fait accompli*, more particularly if it is carried to America.

The Russo-American telegraph line will be constructed as follows:—

A line as far as Omsk, *via* the Ural mountains, will unite Europe with Asia this year, and the following year it will be extended to Irkutsk, so that in 1863 all the Russian ports will be connected through the sea of Japan, Nikolaevske, and the Amoor; and telegraphic communication from the Baltic to the Pacific will be finished in the year 1864.

At the same time, *i. e.*, during the year 1862, the North Americans will construct a line as far as San Francisco, through the scarcely penetrable deserts, wilds and mountainous districts inhabited by the Red Indians.

Thus, in the year 1862-63, there will be two well-constructed telegraph lines, with two conducting wires on the two opposite shores of the Pacific; the one leading to the shores of the Baltic will bring the telegraph news from New York, Boston, Canada, Philadelphia, New Orleans, and from all the Northern States of the New World; and the other from Castries and Wladivostok to Europe will be connected with London, Paris, Lisbon, Rome, Algiers, Naples, Constantinople, and all the principal cities of the Old World.

Between these two telegraphic stations there is that large ocean, the Pacific (several thousand miles broad), which, towards the north, becomes narrowed to about 50 miles, and forms the Behring Straits. To this, the sole point of connexion of the Old with the New World, the attention of several scientific gentlemen has been drawn, who considered it practicable to construct a telegraph between the two shores, and many, amongst whom were Colonel Schaffner (in the year 1854), Liger di Libessard (in 1857), Slegh (in 1859), and the American Collins (in 1861), offered their services to the Russian Government.

But the impracticability of carrying out such a project arises from a fact with which these gentlemen were not acquainted—viz., the nature of the countries around Behring Straits and the Behring Sea, such as Tschukischy and the North-western parts of America, through which aerial lines would have to be constructed. They are so wild, and covered with perpetual ice, that even the maintenance, as well as the construction, would be impossible, as no human being could exist there for any long period of time, and the length of the requisite line would of necessity require some intermediate stations.

No notice need therefore be taken of a project to lay a line in this direction.

But there is another direction—viz., in the southern part of the Behring Straits, which almost seem to be pointed out by nature as the only link by which the Old could be connected with the New World. This connecting link appears in the shape of small adjacent islands, called the Aleutic Islands; and the line from Kamtschatka to America, across these islands, would be about 1,600 miles long. The sea in this region is as broad as the Atlantic between Valentia (Ireland) and Trinity Bay (Newfoundland), but with this difference, that instead of the great and constant breadth of the Atlantic, it is studded with large and small islands, separated by small bays, the largest of which (that of Copper Island) is about 200 miles (350 wersts) broad, the breadth of the others being as follows:—

1	... ...	... 100 miles (175 wersts).
1	... ...	... 70 miles (122½ wersts).
3	... ...	... 50 miles (27½ wersts).
1	... ...	... 30 miles (52½ wersts).
8	... ...	... 20 miles (25 wersts).
4	... ...	... 5 to 10 miles (8¾ to 17½ wersts).
32	... ...	... 5 miles (8¾ wersts).
30	... ...	... 1 mile (1¾ wersts).
Total 80	islands.	

These islands are mostly extinguished volcanoes, mountainous, rocky and woodless. Some of them are inhabited by Aleutes, and some are Russian and American depots. The sea in this part, with the exception of some of the bays, is never frozen over, but sometimes small pieces of thin ice, driven in from rivers, float there, and also sometimes real polar ice.

Without entering into a topographical description of the climate, &c., there, this route may, under all circumstances, be considered as the best and safest for laying down submarine cables.

Such a line can be constructed either by connecting these islands by short submarine cables and aerial lines on the land, or without the latter, by selecting some suitable points (such as ports and inhabited places), through which a long submarine cable could be conducted.

In the first place, such a line would consist of 770 miles of submarine cable, and 233 miles of aerial lines. Such a line would at first sight appear preferable, as the aerial lines interconnecting it would make it so much cheaper than if the whole length were cable, but there would result the following great inconveniences:—

I. Owing to the Aleutic Islands being destitute of wood, the erection of telegraph poles in the stony ground, and the replacing them in case they became rotten, would offer great difficulties in the construction of aerial lines.

II. The many shore-end cables which would be required, mostly exposed to deterioration, especially on the rocky shores there, and generally more expensive than the other parts of the cable, on account of the rocky beds between these islands, would be in danger of soon becoming useless; and

III. These shore-end cables would each necessitate a man to guard it, and by placing two men on each island at least 100 men would be required; whilst at some places water (much less food) can scarcely be found.

From these causes we may safely conclude that a submarine cable all the way from Kamtschatka to America, though in the first instance more expensive, would be more durable, and would bring the different cables to such shores, where there is a safe port and anchoring place.

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The following points could be selected in the Aleutic Islands for such a submarine line:—

From Petropavlovsk in Kamtschatka to—

1.	A village in Behring Island	580 wersts.
2.	Port in the Copper Island	150 „
3.	Port Tschaleskoi, at Attou Island ...	445 „
4.	Port at Kiska Island	300 „
5.	Port Constantine, at the Amschitka Island	155 „
6.	Bay Slava Rosii, on the Tanaga Island	238 „
7.	Bay Nassau, do.	149 „
8.	Village Nicolskoe, on Atka Island ...	192 „
9.	Bay and Village, Umnak Island ...	470 „
10.	Village Illüluk, Captain's Bay, Unalaschka Island...	186 „
11.	Village Schischaldinskoe, Unimak Island	293 „
12.	Village Morschevskoe, Aliaska Island...	124 „
	Total...	3,282 „

or 1,875 geographical miles.

(To be continued.)

The Student.

VOLTAIC ELECTRICITY—*continued.*

Telegraphic Circuit.—The Single-needle Instrument.—We will refer the student who is desirous of becoming acquainted with the practical arrangements of a telegraphic circuit to the engraving at page 81, representing the internal mechanism of the single-needle instrument. This instrument is simply an ordinary galvanometer, with a contrivance for sending a current from either pole of the battery through the line wire. When the line wire and the galvanometer coils of the two instruments at the end of this wire are in communication with the *positive* pole of the battery, the negative pole is brought into contact with the earth, and *vice versa*. The communications of the line wire with either pole of the battery are made by turning the handle of the instrument to the right or to the left.

The Double-needle Instrument.—This instrument, which is now in use upon most of the lines of railway, is merely a combination of two single needles. From the facility with which it is worked, it is always a great favourite with manipulators who have employed it. As, however, it necessitates the employment of two separate lines of wire, it has long been very generally relinguished in favour of various modifications of the Morse instrument, the principle of which we will now endeavour to describe.

The Morse Telegraph Instrument.—The apparatus is composed of a Lever-key or Manipulator, and of a Receiving Instrument. The Lever-key is a simple contrivance for sending a succession of currents along the line. A brass lever moves upon a horizontal axis, passing through a point intermediate between its two extremities. One of these extremities is kept in contact by means of a spring with a piece of metal, to which is connected a wire leading to the receiving instrument. When, therefore, the lever remains in this position, the station is ready to receive signals. The other end of the lever is furnished with a knob; and, when pressed down, brings the line wire into communication with one of the poles of a battery; the other pole being connected to earth. By repeatedly pressing down the lever a succession of signals is, therefore, sent along the line. These signals are *dots* and *dashes*, produced either by an instantaneous or a prolonged pressure upon the lever-key. The receiving instrument is somewhat more complicated, but the principle will at once be rendered evident when it is stated that the dots and dashes are marked upon a strip of paper, which is constantly passing through the instrument while in operation, by means of a lever, one end of which forms the armature of an electro magnet, and is, therefore, attracted every time a current passes along the line. For the more effective working of the instrument, a local battery is, however, generally employed. The current of the line wire, passing through the coils of an electro-magnet, causes its armature to be attracted. This armature is attached to one extremity of a lever; the other end of which, when raised by the action of the electro-magnet, closes the circuit of the local battery, and causes a current to be transmitted from the latter through the coils of a second electro-magnet. The armature of this second electro-magnet constitutes also the extremity of a lever, the other end of which carries a point, which, by simple pressure or otherwise, impresses a mark, representing either a dot or a dash, upon the strip of paper passing through the instrument. By means of various combinations of dots and dashes a complete alphabet and other signals are formed. The signals are now generally marked upon the paper band *in ink*.

Bain's Chemical Telegraph, &c.—In other contrivances, now used to a very great extent both in this country and abroad, chemical agencies are employed. The paper is prepared with a chemical solution and kept in permanent contact, while moving through the instrument, with a point or stylet of iron. The latter, when it transmits the electric current, is acted upon by the solution, and causes a mark, generally of a blue colour, to be imprinted upon the paper strip.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	1s. 11d. to 2s. 11d. per lb.
Negro	1s. 1d. „
Java	1s. 4d. to 2s. „

Gutta Percha.

Fine	1s. 10d. per lb.
Inferior	7d. to 8d. „

January 15, 1862. WM. KIRKMANS.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do B. 7 per cent. till 1862	all	18 to 20	———
20	Do. C. „ „	all	9 to 11	———
Stock	Electric Telegraph . .	100	94 to 97	———
20	Red Sea and India Telegraph	all	19 to 20	———
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	———
1	Do. registered . . .	all	3/8 to 5/8	———
10	Do. „ . . .	all	4 to 6	———
5	United Kingdom Telegraph .	2	1d. par.	———
	Mediterranean Extension Tel.	all	3½ to 4½	———
	Telegraph to India . .	1	¼d. to ¼ p.m.	———

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

TELEGRAPH FAILURES.

To the Editor of THE ELECTRICIAN.

SIR,—I fully coincide with the views of "P. Q.," as to the necessity of your correspondents being "explicit in their statement of facts," "elaborate in the details of experiments," and "logical in their deduction from results," but I differ from him as to the propriety of heading my correspondence as "Telegraphic Failures." I have endeavoured to point out some of the probable causes which have led to disastrous failures, resulting in the reduction to zero of public confidence in the practicability of ocean telegraphy, and not exactly to the *Defects of Gutta Percha.* I have pointed out the treatment which gutta percha covered cores have been subjected to—a treatment which no insulating material could have undergone without deterioration.

I have spoken of the state of gutta percha after being exposed to light and air. Were not the Atlantic, the Red Sea, the Mediterranean, and the Malta and Alexandria cables unduly exposed to such influences? I have stated that such exposure is detrimental to the insulating powers of gutta percha, because it deprives the material of its "insulating sap, moisture, or oil." Mr. Willoughby Smith, no mean authority in gutta percha, states in his evidence that "*gutta percha cannot become deteriorated by exposure where the 'moisture' cannot dry, as in continual use for submarine lines.*"

The following questions addressed to the same gentleman, and his replies amply corroborate my statements.

"(652) *Does not gutta percha undergo a certain amount of deterioration if it is exposed to air without any moisture?*—*Yes.*"

"*Does it undergo a mechanical or chemical change?*—*I think it is chemical.*

"*Does it not become brittle?*—*Yes.*

"*Can it be worked out again for any useful purpose?*—*Not as an insulator; its property is destroyed as an insulator.*"

Let "P. Q." compare "Mr. W. Smith" and "Electrician's" statements, and re-assure himself that nothing is "lost through want of detail and illogical rendering," on the part of the latter.

"P. Q." is startled by a "bold assertion." Truth should be boldly spoken. However high the enconiums, and lavish the praise passed upon the Malta and Alexandria cable as to its insulating capacity, I believe that it has never been, and is not what it should have been, had proper

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and strict electrical tests been applied. Let any of the early manufactured portions of the cable be examined as to the quality and purity of the material by "P. Q.," or any other gentleman interested in the success of telegraphy. I have no fear as to the result, it will prove that "Electrician" has not indulged in simply a "bare assertion."

The cable, undoubtedly, owes its "moderate" insulating powers to the layers of Chatterton's compound. How long that compound will maintain its insulating powers, I am not prepared to say. I trust, however, for the sake of telegraphy the day of its failure is a remote one.

Independently of the cable's insulating capacity, there is another exceedingly objectionable feature in its construction, it has a loose strand of seven copper wires.

Mr. Forde, the engineer, in his evidence supplies a description of the condition of the strand, and I recommend it to the careful perusal of your indignant correspondent "P. Q.," as evidence of the extent of our electrical knowledge at that period, although we are informed that *before finally deciding on this core several eminent engineers were of unanimous opinion that the core was suitable for the purpose, and superior to anything that had hitherto been designed.*

"Have you observed that in the Gibraltar core, the compound does not penetrate thoroughly into the strands of the copper wire, and, therefore, that a sort of tube permeable to the water is made?—Yes, I have observed that I tried experiments upon it; it is a fact that it will allow water to permeate through it.

Would you prefer the tube which is so formed by the strands of copper wire being entirely closed up with the compound? I do not know whether I should prefer it or not; but my objection to having the strand perfectly saturated with this compound is, that I am afraid there would not be a metallic contact throughout the conductor; it is more an electrical objection than anything else; but I may not be quite correct.

Professor Wheatstone: In what way would the compound destroy the metallic contact in your opinion? I think if the strand is perfectly saturated with this compound, the compound may separate the different copper wires, and instead of their being in metallic contact each wire may be separately insulated.

That would be of no consequence so long as the continuity of each wire was maintained? I do not feel myself capable of giving a decided opinion upon it. If there is no apprehension upon that subject, I am in favour of having the strand laid up with compound. It is, however, probable, that induction would be increased, the insulated surface being much larger.

N.B.—Since the above evidence was given a knot of Gibraltar core has been made with the strand laid in compound; and, as far as the experiments upon such a short length can be depended upon, it appears that neither the conduction or the induction are affected. H. C. FORDE."

Why not have consulted Professor Wheatstone in the first instance?

I will here quote Mr. W. H. Preece's evidence upon the subject of a strand conductor ("Report," page 131). "When I came to examine it (the cable) I found that there was a quantity of water in the strand of the cable. I cut a few feet off, but I found there was still more water, and on taking the gutta percha and squeezing it we could make large drops of water ooze out. We had to cut 30 fathoms off, to get rid of this water. * * I think that the sea-water would have acted chemically upon the copper wire and perhaps in course of time would have destroyed it. And in reply to the very sensible question of the Chairman, Captain Galton, as to whether he, the witness, thought it objectionable that stranded wires should be used without some means be taken to fill up those insterstices? Mr. Preece states, "Decidedly; those insterstices should be filled up."

Suppose that by accident the Malta and Alexandria Cable should be severed, how far would the water find its way along the insterstices?

As my only object is to point out the causes which I believe have led to many failures with a view of correction, and not to find fault with gutta percha, I will furnish another instance of a telegraphic failure.

It is really highly amusing, though melancholy, to read Mr. Whitehouse's account of the Atlantic cable's vicissitudes, the false joints of an eminent "*rascal*," and the subsequent subjection of the cable to the "*rack of martyrdom*" are forcibly and graphically described. The effect of strain upon the insulating capacity of gutta percha appears to have been altogether ignored; however, let Mr. Whitehouse and his examiners speak for themselves:—

Mr. Saward: Do you imagine that that joint was made at the Gutta Percha Works?—It was a false joint; a thing made to save trouble after the first covering with gutta percha, and the lazy rascal just patched it together; before it went through a second covering, there was no real joint made. The gutta percha went over it, and then it went through a second covering, and it was not discovered till it gave out in this way in the tank. I said "If any careless rascal has done that once, he may have done it again." "What are we to do?" There was a length of several hundred miles lying at the Gutta Percha Works already completed when I detected this flaw, I said, "I have no confidence in that unless it is tested." It was evident that it was no use testing it by the ordinary test for continuity, and I desired it to be tested with a strain, so as to draw these ends asunder. I said "We must put the whole of this under just strain enough to detect if there is a breach of continuity."

Chairman: Was it done?—Yes.

Mr. Saward: What was the strain put upon it? I tried a great many experiments to determine how much strain would show these bad joints without producing the least stretch; of course, we could not produce any permanent stretch without injury. I tried to determine by the friction-brake, or some arrangement of that sort, how much strain could be put on to detect any break of continuity that occurred.

Did you detect any other flaw? Yes, we had a second.

Mr. Varley: Do you remember how much strain you put upon it? It was estimated at about 40 pounds. Yet, although you know how many pounds weight you put upon the friction-brake, but you cannot always tell what strain that gives; there is a source of accident you could not determine, and could not avoid. During the process of winding under strain (it could not be wound by hand, it was wound by steam) there was a large drum, and a swift from which the core was to run, when the drum began to be filled with the core, the circumference was small, and the winding took place slowly, and the core came easily off the swift; but as the drum filled and its circumference got larger, each revolution then took off nearly three times as much from the swift as it would before, as you came to the small part of the swift the velocity of rotation increased rapidly, and the speed of the swift was about as much as four times what it was in the beginning, so that the friction varied; we had to stop sometimes, because the swift would be overrun and there would be jerks, and the inertia then would give the core a stretch, so that it was subjected to a trial that really I should be very sorry to subject a cable to again."

Mr. Whitehouse, in reply to a subsequent question as to what he attributed the failure of the cable, replies:—"I think the combination of causes I have mentioned with the subsequent straining and stretching during paying out is quite sufficient to account for its failure."

I am quite as willing as "P. Q." to allow gutta percha to pursue the "*even* tenor of its way;" but I protest against the treatment to which it has been subjected, as I would in the case of any of the other insulating gums with which we are acquainted. That a glorious future remains for ocean telegraphy no one doubts, but do not let us ignore the lessons of the past.—Yours, &c. ELECTRICIAN.

January 13th, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—Your correspondent "Au Revoir," in writing upon Standards of Electrical Measurement, observes that a statement made by myself and Sir Charles Bright, to the effect that the *quantity* of electricity sustained by induction varies, *cæteris paribus*, directly as the tension may be paraphrased by saying, "It is well known that the static electrical force, acting between an inducing and an induced surface, all other things being the same, varies in the simple ratio of the quantities of electricity in action," and points out that various writers have shown that the force varies as the square of the quantity.

Your correspondent, however, will, I think, perceive that he has fallen into the error of confounding electrical *quantity* with electrical *force*. The force is always stated to vary as the square of the quantity, but this circumstance is not incompatible with the statement that the quantity varies directly as the tension, proofs of which are readily obtainable, as may be perceived on reference to pages 282 and 307 of the Government Report.

The subject on which "Au Revoir" writes is a very important one to practical electricians, and further opinions upon it are greatly to be desired.

The gentlemen who constitute the committee to report to the British Association, are but little connected with practical telegraphy, and there is a fear that while bringing the highest electrical knowledge to the subject, and acting with the best motives, they may be induced simply to recommend the adoption of Weber's absolute units, or some other units of a magnitude ill adapted to the peculiar and various requirements of the electric telegraph.

My own views on the subject of electrical force are peculiar, but have not yet attracted the attention of electricians. I do not believe that the attractive or repulsive force varies on the *square* of either the quantity or the tension, *per se*, although it is always stated to do so. I believe it to vary simply as the quantity, and simply as the tension, but since the one of these functions almost always varies in the same degree as the other, it has become a usual but slovenly mode of expression to say that it varies as the square of the one or the other, as the case may be; if we put one measure of electricity upon an insulated conductor, it exerts a certain attraction upon a neighbouring body; if we add another measure the attraction is increased four times. According to the views above stated, two parts of this force are due to the increase of tension, which is doubled; and two to the increased number of particles in action, which is also doubled. It is possible, by inductive influence, to cause the quantity to vary while the tension remains constant, or *vice versa*, and then the force does not vary as the square of the changeable function, but in the simple ratio. I am leaving England for a few months, but hope, on my return, to publish experiments which demonstrate this.—I am, sir,

1, *Victoria St., Westminster, Jan.* 8, 1862. LATIMER CLARK.

THE CURRENT IN COILED CABLES.

To the Editor of THE ELECTRICIAN.

SIR,—Your correspondent, "W. H. P.," in whose style and initials I recognize a well-known electrical engineer, has very ably called attention to

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the electrical effects exhibited in a coiled submarine telegraph cable, and has refuted the vague insinuations of "Investigator," who, if I interpreted his meaning rightly, would imply that the so-called "false discharge" (or, as I have generally called it, "coil current"), is nothing more than a current of polarization set up either at faults in imperfectly insulated cables, or at the earth plates of the circuit.

As the subject is of interest to electricians, I will venture to intrude on your space to offer a few remarks.

First, let me observe, that "W. H. P." has made one, I think, erroneous statement. He says, in trying to account for the different views arrived at by Professor Wheatstone, that—

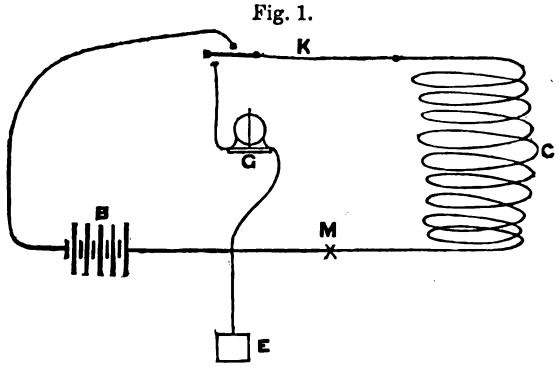
"It may be that he never had a sufficient length of wire properly coiled under his command to produce such effects. He certainly had not at the Government experiments."

Now, it was in October, 1859, that I had the pleasure of showing the "coil current" both to Professor Wheatstone and to Professor Faraday, at the Government experiment workshops. I had previously forwarded my letter in the *Engineer* to Professor Faraday, and he recognized in the description the same effects as those he describes in his "Experimental Researches," under the head of the "Induction of a Current on Itself," and expressed himself little surprised at the effects he witnessed. The wire we had there (20 miles) was ample for the purpose, as the effects were unmistakable.

Shortly after this I left for India, and saw nothing more of the Government experiments, and it must have been after this date that Professor Wheatstone performed his experiments, but whether the coils were removed directly, or left for some time for Professor Wheatstone to experiment on, I cannot say. At any rate, for several days Professor Wheatstone witnessed the coil current, and had the opportunity of testing the accuracy of the deductions I had arrived at as to their cause.

There is one point, however, which alone would entirely upset the theory that the currents in the experiments *I* performed were "polarization currents, and that is, that as we had only *one earth connection*, no polarization could possibly occur. I will now detail the experiments, and show how it is that in some cases these currents are not visible, whilst in others they occur with great intensity.

Fig. 1.



The wire experimented on consisted of:—

Coil A, 5 miles. No. 16 wire, covered to No. 1 Guage with gutta percha.
B " " " " Chatterton's compound on wire.
C " " " " Chatterton on wire, and first covering.
D " " " " Chatterton outside only.

Coils A, C, and D, were coiled up dry in shed, each in one coil.

Coil B was in water, and in 3 separate coils.

Batteries, 144 cells, Daniell's. Galvanometer, a delicate vertical instrument.

The connections are represented in fig. 1; where B is the battery; G, galvanometer; E, earth plate; K, key, which when left untouched, pressed upwards, and connected the top of the coil to one pole of the battery; the other pole of which was permanently connected to earth, as also was the lower end of the coil of wire. When the key was pressed down, it connected the top of the coil to the galvanometer wire, the other end of which was permanently attached to earth. It will be seen, therefore, that only one earth connection existed; moreover, this consisted of great surface, being attached to the water and gas pipes.

Now all these arrangements are such as to exhibit the ordinary discharge or return current, when the key is depressed, and thus allowed to connect line to galvanometer. If we insulated the lower end of coil from earth at M, we should on using the key obtain the full discharge of the line as a Leyden jar, and supposing this to deflect the galvanometer to the left, we should know that was the direction which should be given by the ordinary discharge when it is connected to earth, because the discharge when the distant end is to earth is only a modification of the discharge when the distant end is insulated.

This being understood, the coils were tested for discharge with the end M insulated, and the direction and amount of deflection noted. The end M was then connected to earth, and the key again moved. The deflection was now *reversed*, instead of being merely modified, as should be if the ordinary discharge occurred; the deflection showing a much greater current, but in the reverse direction to the ordinary discharge, and consequently in the same direction as the primary current. The following are the results:—

Extract from Notes of Experiments at Gloucester Road, Oct. 25, 1859.

	Discharge with end M insulated.	Coil Current with end M to earth.
"Coil A	5° left.	26 to 30° right.
C	3° "	30 33 "
D	2° "	3 to 4
A + D	4° "	35
A + D + C	9° "	56 to 58 "
A + D + C + B	15° "	58 to 60 "
B	10° "	Variable.

"With coil B, with end M to earth, on Professor Wheatstone's galvanometer (a very delicate vertical), could nearly always get a single 'coil current' by *the sharp tap and let go*, and always an ordinary discharge *by a slow tap and hold down.*

"Could also keep needle over to 45° on either side by giving these peculiar taps in rapid succession."

With the dry coils the ordinary discharge when the end M was insulated was, it will be seen, feeble, but in the coil immersed it was just strong enough even when the end M was to earth to balance the coil current, so that by a peculiar tapping either current could be made visible on the galvanometer. Now this is a point to which I wish to call special attention. It is evident that in all the tests of this sort it is only the result of the *difference* between two conditions tending to produce opposite effects which we observe. For the ordinary discharge tends to move the needle in one direction, and the coil current in the reverse. The conditions for producing the ordinary static charge, and consequently the discharge, are favourable in the case of a submerged wire; whilst they are at their minimum, when the wire is neither submerged nor surrounded by any armature of iron wire. The conditions for producing the coil current are the most perfect when the diameter of the coil is small and the wire closely laid, and all in one coil. They are less when the coil is large.

It is evident, therefore, we may have such a combination of these conditions that either the static charge or the coil current may predominate, or that they may be, as in the very peculiar case I allude to, so evenly balanced that either may be observed. Thus it is very possible that if a *wire covered* cable be coiled in a very large coil the static charge will overpower the coil current and consequently the coil current would be sought for in vain.

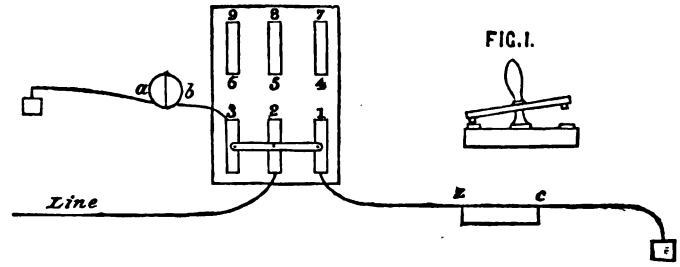
On the other hand I had the opportunity once of testing 70 miles of *hemp covered* gutta percha covered wire coiled dry in the hold of a ship. Here the *coil* current was such that it not only was the only current visible, but so powerful that it held the needle over for several seconds.

In the experiments I give above the dry coils give a strong coil current. I need scarcely remark that in all cases the coils were most perfectly insulated, and as these currents occur as I have shown in a metallic circuit, it seems evident the effects noticed have nothing to do with polarization of earth plates, or faults.

I will now make a few remarks with regard to Professor Wheatstone's experiments as detailed in his Report, and in which Professor Wheatstone endeavours to prove that these coil currents do not exist, and that what has been observed by Professor Faraday, Professor Thomson, Mr. L. Clark, Mr. Jenkin, and myself, and many others, and set down to the coiled state of the wire, is nothing but the effect of a current produced by the polarization of the two earth plates.

Professor Wheatstone gives no diagram of the circuits; but refers to figure 1, consisting of a key which I have represented (fig. 2). The

Fig. 2.



parts numbered 3, 2, 1, are the only parts used in these experiments. Professor Wheatstone thus describes the connections: "the copper pole of the battery was connected with the earth, the zinc pole to 1, one mile of wire, ¾ in the water tank, was connected with 2, the other end remaining insulated. "The binding screw, 6, of the galvanometer was connected with 3, and the binding screw *a*, with *another earth wire different from that of the battery*. The real discharge current was ascertained to be 7·2° towards the left. The insulated end of the mile of wire was then connected with the earth, 512 elements still continuing to be employed."

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Now Professor Wheatstone here states that the galvanometer was connected to "*another* earth *wire*, *different* from that of the battery." He does not say another earth *plate*, but it is pretty evident that such was implied, since other diagrams in his report, as well as the result of his experiments, and his own reasoning on the subject, lead to this conclusion. He then states that the end of the mile of wire was connected to earth, but he does not state whether to a third earth plate, or to which of the former two it was attached. If it was connected to the same plate as the battery, then all the effects he observed would be fully accounted for. The two earth plates would be polarized by the battery current, and when the battery was cut out, polarization currents would flow through the galvanometer, and the less resistance there was in the circuit the greater would be the intensity of the currents. This coincides *precisely* with the results the Professor obtained, for when only 4 feet of wire were employed the result was much stronger. "The first deflection was 90° towards the left, which was followed by a permanent deflection of 65° towards the right, a similar experiment was made with a single cell with like results, the deflections only being less." "The causes of these effects are," he observes, "the polarization of the plates or masses of metal, connecting the ends of the wires with the earth."

So far I entirely agree in the opinion as to these experiments as performed by Professor Wheatstone, but he goes on to say—"The first effect is produced by the polarization of the terminal which connects the telegraphic wire with the earth, the record by the polarization of the terminal which connects the galvanometer with the earth."

I should explain this change of deflection differently, for it seems incorrect to me to allude to the polarization of a *single plate*, but it is not my intention to discuss this.

It will be seen, therefore, that Professor Wheatstone's experiments were totally different from mine—and further, that their result was different, because in Professor Wheatstone the *shorter* the circuit the more intense were the currents; whilst in mine the *longer* the circuit the more intense were the currents.

The results on coil D in my experiment did not appear to agree correctly with the others, it is possible that this may have been caused by some of the coil being coiled in a reverse direction to the rest, for each of these 5-mile coils were made up of many coils piled up one on the other.

As these currents occur, as I have shown, in a metallic circuit, touching earth in one place only, and as the effect increases with the length of the circuit, it is evident they have nothing to do with the polarization of the earth plates, or faulty places, and as they are only observable in coiled wires it seems correct reasoning to attribute their existance to the inductive action between the convolutions of the coiled conductor.

In conclusion, if Professor Wheatstone is right, then Professor Faraday, Professor Thomson, Mr. Fleeming Jenkin, and myself, are wrong. If, on the other hand, we are right, then Professor Wheatstone, during his brilliant career in scientific research, has been sufficiently often *right* to afford admitting himself, for once, in error. I think it right, in any case, to make this protest, as the name of Wheatstone, in a Government and official report, must naturally carry such weight with it, as to lead to general acceptation of what I maintain is an erroneous conclusion; and I feel some interest in this matter being set right, because I believe I was the first to call attentlon to the subject, having observed these currents first in 1856.

F. C. WEBB.

To the Editor of THE ELECTRICIAN.

SIR,—"Who shall decide when doctors disagree?" is a question put in all disputable cases with the apparently utter hopelessness of despair. But men of common sense eschew the doctrine and decide for themselves.

All the fine spun theories of all the 'opathies of modern Esculapians are disregarded, and wisely, by the class above mentioned; from the fact that generally speaking they are practically useless: for while each with his pet is running full tilt at the others in deadly tournament, the unfortunate who is to be benefited by their airy speculations, might languish and expire, were it not that the contempt of their theories supersedes the theories themselves, and nature, aided by a little practical common sense, effects the cure without either flourish or ostentation.

And the lamentable and unseemly strife among eminent scientific men, upon certain electrical and telegraphic points, is no less objectionable and preposterous; and a fit subject for ridicule were the matter less grave. Each seems to have a pet theory, which he persistently sticks to in the teeth of conviction. The present writer has been at some pains to comprehend a few of these theories, but has given it up in despair, and has made up his mind to one of the two following conclusions, either that your humble servant is an unmitigated blockhead, or that the said theories are so dreadfully shadowy, that the prolific parents of them cannot take in their outline. Of course in this theoretic battle a most delightful mist is engendered, of vague and indefinable views, expressed in an almost unknown tongue, and with most hazy verbosity. In this, their Elysium, let us leave the awful chiefs, and descend to a little plain matter of fact, as to the relative merits of gutta percha and caoutchouc.

Gutta percha having had possession of the field so long, is not unnaturally indignant at the appearance of her modest rival, and treats her as a poacher upon the vast domain, which hitherto have been her own preserves; and of course all sorts of things are said, theories propounded, and results arrived at, of the most surprising character, tending to the glorification of gutta, and the utter confusion of rubber. Well, perhaps all this is perfectly natural as the world wags. Had your humble servant, the writer of these lines, been a thriving tallow chandler at the period when the discovery of gas began to supersede the use of his matchless dips, he would probably have opposed the brilliant innovation with warm indignation, and have been at some considerable pains to prove its infernal origin, as having been the meteor which lighted up the lurid halls of Pandemonium. Dips are excellent things in their way, when nothing better is to be had, and so is gutta percha. We all respect "Old Gutta," it has done us infinite service, and a great deal might be said in its favour without reaching the climax of absurdity, by attempting to prove it as *the* insulator *par excellence*.

But away with all cobweb theories on both sides; divest the matter of the superfluous drivel of theorists who seek to make a parade of their scientific knowledge or mathematical attainments, or whatever hobby they choose to ride before the public; and of the soft sawder of interested partizans who profit by upholding, with their pen or any other instrument they can best use, a monopoly which only the wealth of a millionaire could sustain; and of a still more objectionable class, who would mystify so simple a thing with a mass of unmeaning verbiage, as clever divines do the plain truths of Revelation, or lawyers the incontestable principles of right and wrong; I say away with all this sort of thing, and bring the simple matter to the test of practical common sense.

Let any unprejudiced reader, with only moderate acquirements, compare the two materials and judge for himself; believe me it is a very simple thing, this insulating of the conducting wire; the matter really lies in a nutshell, and if any one wishes to make a mountain of a molehill, the mountain has about as much foundation in fact as the bogey in your coal-hole, with which you scare the little ones in the nursery. Examine these two materials, viz., gutta percha and india rubber, either in the lump, or when applied in the best manner to the wire; keep in mind the essential requisites of a good insulator, which of course I need not enumerate, and tell me if there is not undoubted evidence of porosity in the former: What, you say all bodies are porous! perhaps they are; at all events philosophers say so. I am no philosopher, but I think your philosopher would require a glass of considerable magnifying powers to find the pores in pure caoutchouc. Need I remind you that it is just possible that the wire, when charged with electricity, may lose a considerable part of the charge in a journey of, say one hundred miles, by escaping through the pores of the insulator, and hence is it not self-evident that the less porous a body is the better insulator it must of necessity be; and that caoutchouc fulfils this condition to a far greater extent than gutta percha, is an indubitable fact; while in the other essentials of a good insulator, it is also far superior. What is the use of carping about treacle and decomposition, you can scarcely expect a good and substantial work done with inferior materials. And now all this leads me into a wide field, where there is plenty of room to descant upon a variety of matters necessarily involved in the foregoing, such as the right sort of stuff to use, its application to the wire, &c. &c., in order to construct a thoroughly good core suitable for submarine cables (for this is the all important matter with which telegraphists have *now* to deal), which I propose touching upon at some future time, with the kind permission of the Editor, and the generous forbearance of his numerous readers.

MOMUS

January 14, 1862.

TRANSATLANTIC TELEGRAPH.

To the Editor of the ELECTRICIAN.

SIR,—All England responds to your ventilating this most important subject; all admit your premises, and the great value, nay, more, dire necessity of the establishment of instantaneous communication with the Canadas, if such can be accomplished, money at the present juncture being comparatively no object.

Notwithstanding all the failures and mishaps that have occurred in deep-sea telegraphy, and which are traceable to preventable causes, there are really no insurmountable difficulties in laying a submarine telegraph cable across the depths of the Atlantic, provided always the mechanical application of known principles in its construction are not at variance with the simple laws of natural philosophy.

The failure of the late Atlantic and others in deep waters was not the least surprising, and was easily foreseen and foretold before a mile of cable was submerged, being one and all constructed on principles totally at variance with the requirements and circumstances in each case, as the results have too truly exemplified.

It is not fair, however, to make out that such failures occurred from the inefficiency of the insulating material, the gutta percha, which can point to so many practical testimonies in its insulating efficiency, of lines still working well after many years of submergence, where its primary condition as an insulator has not been destroyed or injured by tension during submergence from the mechanical misconstruction of the cable.

There is plenty of experience as to the relative cost, application, efficiency, and dielectric qualities of gutta percha and india rubber as insulating media for such purposes, which may be safely left to those who are to direct the expenditure of other peoples' money, who, in turn, for their own interests, must see more carefully in such matters, not only to secure the right man in the right place, but the right means to the end in view for carrying out such an all important undertaking as a telegraphic communication between Great Britain and the Canadas, which line, when

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once an established fact, will be but the first section of a general system of telegraphy connecting Great Britain with her colonies and dependencies all over the globe.

It is wrong to talk of the late Atlantic cable having some few faults only in its insulation. So far as its electrical working conditions go, it has been smashed up from end to end long ago. No matter as to that, mechanically speaking, it could not be raised within a few miles of the coast; but the fact still remains, and it is a great fact, that, notwithstanding it was about the grossest and most ignorant piece of bungling yet perpetrated in its electrical capacities and mechanical combinations for such a purpose, still, the line, as a line, no matter what it was composed of or how, was laid in continuity between the shores of the Old and New World. This fact alone gives to abstract philosophy the power to state that there is no insuperable difficulty to lay an efficient electrical conductor over such distances, and through such depths, provided always the means to effect it dovetail properly into the requirements of the case, in fact, success may be looked upon as certain as the arrival of a Transatlantic steamer.

In a commercial point of view, if such communications be designed upon a system of direct lines, without the intervention of intermediate and trafficless stations, then the working expenses may be comparatively so light as to permit of a low rate of tariff, which insures a large traffic, and is in itself the true element of commercial success.—I am, sir,

London, Jan. 10. THOMAS ALLAN.

THE PHENOMENON OF FALSE DISCHARGE.

To the Editor of THE ELECTRICIAN.

SIR,—Notwithstanding the austere rebuke administered by your correspondent, "W. H. P.." I believe that what he pleases to designate "an anonymous sneer" will eventually "bear good fruit," and will effect the object the writer of the letter in question had in view. My letter was simply a protest against an assumption on the part of a few to an amount of superior erudition incompatible with the present extensive knowledge and experience possessed by a numerous class of practical engineers and electricians. Scientific investigation and physical research will at all times command consideration and respect; but when those engaged in such investigations and researches arrogate to themselves the sole and exclusive right of discovery regardless of the well known merits and claims of others, "courtesy and gentlemanly feeling" demurs, and very properly so, too.

I am, to a considerable extent anticipated in my reply by your correspondent the "The Piper," whose "Phenomenon of Telegraphy" is both diverting and instructive.

Your correspondent, "W. H. P.," has my thanks for his able dissertation "On False Discharge;" but I differ from him as to the cause, and will, with your permission, in an early number state the reason why.

INVESTIGATOR.

SMEE'S BATTERIES.

To the Editor of THE ELECTRICIAN.

SIR,—In your impression of December 13, a correspondent signed "A: H. B." makes a statement regarding Smee's battery. It states that Smee's battery is a very powerful arrangement, but is liable to great objection in practice, and is therefore seldom used. I shall take it as a favour if the writer of the above will state what these objections are. I find it a very useful battery, easily managed, and constant in its action, if properly made. As an instance of this I have had a Smee's battery in constant action for six months with once charging, working a clock; this I have repeated a great many times, and once my battery worked on for seven months. The battery consists of one zinc plate and the ordinary piece of thin platinized silver, the zinc plate being about 3 inches by $7\frac{1}{4}$ thick, well amalgamated, and standing in a small shoe, with mercury in, and the back of the plate protected from acid by a coat of varnish; there is no offensive smell from the battery. I put one in action on New Year's day (1862), that I expect will continue in constant action until next New Year's day (1863), without interference. Want of time prevented me writing earlier, also saying more at present. I shall feel obliged if you will insert the above enquiry, if you think it worth a corner in your valuable paper.—I am, sir, yours respectfully,

Accrington, January 13, 1862. DAVID TUNKS.

[The statement in question was our own, in answer to an enquiry of "A. H. B." For the purpose of experiment the Smee battery is a very cleanly and convenient arrangement; but the practical objections we referred to become evident when we compare it to the Daniell couple, or others on the same principle. In these the zinc element may be immersed in pure water, and thus be acted upon only by the acid which is set free from the salt in contact with the copper or negative element, in consequence of voltaic action. The expenditure of zinc is therefore greatly reduced in the Daniell's battery; and the necessity for amalgamating the metal, in order to avoid the waste due to what is termed local action, is obviated. Again, you will probably find that your negative element of platinized silver will ultimately become coated with a deposit of zinc from the solution of sulphate of zinc in contact with it, an effect which will greatly impair its efficacy. To work an electric clock requires, however, but a very small power, and scarcely forms a test of the action and constancy of a battery. Electric clocks have been worked by a couple of plates, zinc and copper, simply buried in the earth.—ED. E.]

To the Editor of THE ELECTRICIAN.

SIR,—In the *Times* (in fact all the daily papers) of the 7th inst., there appeared the following telegram:—

"By Telegram from Alexandria.

"*Canton, December 30th.*

"A *coup d'etat* has taken place at Pekin; a new ministry has been formed under the presidency of Prince Kung, &c."

Now will you or any of your correspondents be good enough to inform the public, the *precise* truth in reference to the date of this telegram? Moreover, on the 11th inst., the following telegram is published in the same papers:—

"China.

"*Pekin, November 11th.*

"A *coup d'etat* has taken place here, &c. &c. Prince Kung has been appointed President, &c."

It appears, therefore, from these telegrams (dated 11th November from Pekin), that the intelligence took six weeks to reach Canton. But how are we to account for this *unprecedented speed* of communication from Canton, in seven days?!!

Now, sir, it is quite evident that there is some mystery in connection with the working of the Alexandria Cable; so let us hope that the Government will make the strictest enquiry respecting the state of this cable, and in future not let any company have the privilege to monopolize any particular route or line of telegraph leading to our colonies (except those which have already been conceded, and ought to be revoked). It must be admitted that "*concessions*" give great power to a few "*millionaires*," which constitute in themselves a "*monopoly*," thereby preventing all private enterprise, free competition being assuredly most desirable in matters of such great national importance. In conclusion, I say, let us have "*free trade*" in the "working" and "construction" of submarine cables, in order to destroy the present baneful system of monopoly. When the former has been obtained, we shall then have telegraphs to all parts of the globe; and we do hope in the next session of Parliament that a strict enquiry will be made respecting the existing lines, likewise all future telegraphic cables that the Government intend to construct. It is quite certain there has been but little encouragement given to any particular inventions in submarine cables; it is, moreover, true that the Government Committee condemned the use of any "*new insulating agent*" for cables; yet, at the same time, they allowed the inferior compound known as "Chatterton's" to be used in the Red Sea and Alexandria Cables, respecting the latter of which the public can gain no *intelligence*. —I am, sir, your obedient servant, W. HALL.

Mansfield Street, Borough Road, Southwark, E.C., 14th Jan., 1862.

Miscellanea.

THE FOLLOWING are the provisions of the circular, dated, 7th December, 1859, addressed by the French Minister of the interior to the Prefects of Departments, relative to the authorisation of private lines of telegraph. In cases where the application for the establishment of such lines shall be favourably considered, the Government reserves to itself the right:—1st. To place wires, without any indemnity, upon the poles or other supports of the authorised line. 2nd. To authorise its agents to supervise or control the forwarding of dispatches; the expenses of such supervision being defrayed by the concessionaires. 3rd. To suspend, or if necessary to suppress, without indemnity, the authorisation granted.

To Correspondents.

NIL DESPERANDUM.—We believe that several of our late heavy failures in submarine telegraphy was owing to the inexperience of those intrusted with the operation of laying down cables. Engineers have been employed who had no knowledge whatever of submarine telegraphy, or even of the nature and character of the materials of which the cable was formed. The case generally has been an engineer having a speculative turn of mind starts a company and gets himself promoted to the responsible post of engineer. A submarine telegraph engineer should be accustomed to the sea, and well acquainted with the duties of a sailor as well as the general routine on board ship.

L. R.—The ELECTRICIAN can be procured at any railway station.

CABLE.—We shall continue to publish in our columns the evidence given before the Government Committee on submarine cables.

FOLKESTONE.—We would recommend Highton's History of Telegraphy, or Walker's Telegraph Manipulation, which can be furnished by the publisher of this paper. Noad's Manual of Electricity is a very complete work for the *general* student of electricity. Under the heading "The Student," a series of elementary lessons are being given in our paper, which will to some extent enter into the subject of electro-telegraphy. In the French language, Gavarret's Télégraphie Electrique is a standard work; but occasionally somewhat abstruse.

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The Electrician.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

1. THERE is nothing very exciting in the beginning of a novel; the reader works through its first few pages rather drily, that he may comprehend the materials of the superstructure in which he is to become interested. And so it must be with what we are now undertaking for the benefit of the student in electricity; we cannot expect the preliminaries through which we shall have to conduct him to prove very interesting, but we will take care to make them as few and concise as a proper solicitude for his advancement will admit of; and if, at first setting out, he know this to be our intention, he will, we think, be the more inclined to master every difficulty as it arises, though he should occasionally meet with what for the moment he may imagine he might as well skip over and go on. Our object will be to make him proficient with as little pains to himself as possible, and we trust that, in the end, he will approve of the means we shall have used for the purpose. The plan to be adopted is, first, to take him to a good starting ground, giving him to understand why we prefer it to others; and then to proceed step by step by such experiments as he will be able to repeat after us, adding their plain indications together, until, in their totality, they present to his judgment the main features of a complete and consistent system. In this manner we hope to make him, in a little time, a sound theoretical and practical electrician; but, he must not "skip!"

2. Electricians divide their science into Statical and Dynamical Electricity, for the sake of being able to consider the force which is at work under two points of view:—namely, when tending, first to a state of rest, and, secondly, to a state of motion. It need hardly be explained to the student that there must be a force reciprocal between electricity and common matter; for, unless there were, the former could not put the latter into motion, as it does in what are called electrical attractions and repulsions, nor common matter put electricity into motion, as we see it do when an electrical spark leaves one body to strike upon some other; neither could electricity, if devoid of force, establish the static equilibrium to which it constantly tends, and of which the divergence of the gold leaves of an electrometer affords an example that would be a permanent one if the instrument were only surrounded by an atmosphere perfectly insulating and immovable.

We may conceive force to be of a nature to act in straight lines projected to any distance through space, or in rays diverging from, or converging to, certain points; in the former case it would be a linear force, and in the second, what is well described by calling it a central force. Gravity is a force of the latter kind; the same thing has been long taught of electricity, but a doubt has lately been raised whether certain polarizations, which it seems to occasion in the particles of common matter, may not be better accounted for by imagining it to act in short lines, extending from point to point; which doubt, for want of an efficient theory, has not yet been set at rest. Again: force, if it be central, may operate in either of two directions; namely, from the centres, in which case it would tend to push them asunder, when it might be called *repulsion;* or towards the centres, when we should conceive it to draw them together, and with propriety call it *attraction*; or, finally, it may draw certain centres together and push others apart, and then we should say it had the two opposite natures of attraction and repulsion. All this must seem very complicated to a learner, but he need not be discouraged by the prospect before him; for he will soon be enabled to occupy himself with only certain parts of it that are true, and they will be found sufficiently simple. He may ask whether the force that works to establish static electrical rest is the same as that which produces dynamic electrical motion? All we need say at present on that subject is that if one force will answer both purposes we shall find it out as we go along. What it behoves him to know here is the nature of the force that rules in statical electricity, even though he be destined to become a telegraphist whose proper department will be dynamical electricity; for he cannot expect to make much progress in learning how electricity is put into motion until he first inform himself of the conditions necessary for maintaining it in a state of rest.

3. This being premised, we may immediately turn our attention to the theories of electricity that have been formed on these conceptions of force. One of them was communicated from America by Dr. Franklin in the year 1750, its fundamental principles having been there published by him three years earlier, while, independently, the same thing was being done in England by Mr. Watson, afterward Dr. and Sir William. In that theory electricity is represented as a kind of matter of very subtle nature and great energy, attracted without limit as to quantity by bodies in general, its own particles at the same time repelling one another. Its author compared the absorption of electricity by common matter to that of water by a sponge, more or less of either fluid being attracted into the absorbing substance, as its pores happened to be at the time more or less open, any excess that might arise resting necessarily outside its surface. The notion is crude enough, but still its resources as a theory were examined by Mr. Æpinus, at St. Petersburg, and by Mr. Cavendish, in London; neither of those philosophers, however, could make it tenable, even to the very limited extent that they attempted, without adding to it a repulsion in the particles of common matter for one another, which was an assumption that could not be granted.

4. That theory was opposed by another, co-existent with it from the beginning, and which needs two electricities to be in existence, each repelling its own particles, but attracting those of its fellow, as well as common matter. This theory, originally projected by Du Faye, in France, and afterwards erected into a mathematical system by his countrymen, Coulomb and Poisson, enables its advocates to avoid imputing to common matter the self-repulsion of the Franklinean system; but it involves a greater number of physical agencies; thus departing further from simplicity, while, at the same time it assumes, in common with its competitor, what no one will concede, namely, that electricity, when added to bodies in excessive quantities, is confined to its surface by some kind of pressure by the atmosphere that it cannot overcome.

5. The student will naturally inquire whether theories, so little conformable to nature as to lean upon what is known to be untrue, can be useful, even as artificial helps? The answer one and all must give to the question is—that *the prevailing systems leave perfectly untouched the main difficulties of the science;* but they are not abandoned, for we cling tenaciously to what is imperfect rather than resign explanation altogether: besides, we entertain a hope that our experience of the imperfect may suggest to us an improvement. In the meantime we must never delude ourselves with the idea that the inefficiency of our theories is their greatest evil; their shortcoming indicates their foundation to be artificial, *at least in part*, and so far as their principles

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vary from those of nature, they must already have told us what is untrue; so that their partial conformity to facts, proceeding from what they contain of truth, is no guarantee that their application as a whole could be extended without leading us further astray. We are justified in selecting a particular theory by its comprehending a greater number of facts than any other; but if the forces upon which it is based be artificial, the causation it assigns must be, to a corresponding extent, a misrepresentation.

6. We deem it unnecessary to describe at large a modification of the theory of Du Faye, made in our own times, by representing electricity to be a combination of mere forces in the abstract, and without any peculiar matter of its own for them to be connected with; the idea was intended to simplify theory, but its success in that respect may be disputed, while it leaves abundance of facts unsatisfactorily accounted for. Its talented and estimable author, inclining to view electrical force as something more than attraction and repulsion, and different altogether to a central emanation, endeavoured to trace its propagation among contiguous particles of common matter, through lines that might be either straight or curvilinear, until he finished by introducing into the sciences a new difficulty until then unheard of; for while he left cause and effect equal, according to mechanical axiom, so often as one establishes the other in solid or fluid bodies, he denied the same equality, in subversion of the axiom, whenever the same cause is producing the sume effect in bodies that are gaseous. We do not say that this anomaly was an inevitable consequence of the theory; but it was its consequence, and certainly the theory is not a safe guide.

7. These complicated and unproductive views of electrical action have been brought forward, because the student will need to be acquainted with them as prominent features in electrical history; though he may never attempt to master their difficulties; very few of the present or past electricians have essayed to do so, the object to be attained being reputedly not worth the labour; indeed, it is doubtful whether genius itself has often been learned enough in mathematical appliances to have successfully undertaken such a task, even had the inducement been much greater.

8. The *natural* electrical theory, if we find it, will doubtless be profound, but it need not be complicated; there is such a thing as the profundity of simplicity, and it would be no small evidence of the natural basis of any theory of electricity, if it were accessible to an every-day amount of sagacity, and an ordinary acquaintance with numbers; while, at the same time, it was comprehensive, not only tracing, on mechanical principles, all electrical phenomena from the same system of causative force, satisfactorily assigning their observed distinctions to differences in surrounding conditions, but also determining, still on mechanical principles, whether other facts classed under kindred sciences have, or have not, an electrical origin, and if they have, bringing them within their own proper domain. Of late years it has become almost impossible to doubt that magnetism is an effect of electrical force, modified by circumstances of which we have no adequate conception; and we may reasonably expect that if we be brought to know the relation which electricity bears to common matter, we shall not be long before we perceive also the relations of magnetism to both common matter and electricity.

9. Before we dismiss the old theories as incompetent, we will epitomize them for the sake of making them more easy to be borne in the student's recollection; and that he may the better appreciate what we have to substitute for them.

The American Theory involves

an electrical fluid, repulsive of its own particles, and attracted by common matter in unlimited measure. A repulsion in the particles of common matter for one another. And a pressure by the atmosphere on electricity for confining it, when superabundant, to the surfaces of bodies.

The French Theory involves

two electrical fluids, each repulsive of its own particles, and attractive of the particles of its fellow. An attraction of each electricity in unlimited quantity by common matter. And a pressure by the atmosphere for confining either electricity to the surfaces of bodies when it is connected with them in excess of the other.

10. Our immediate endeavour will be to improve upon the former of these systems, by removing from it what we must represent as superfluous encumbrances, namely, the force of repulsion altogether, confinement of electricity by atmospheric pressure, and the unlimited character of the attraction of electricity by common matter. As thus altered it involves only what follows:—

One Electrical Fluid attracted by Common Matter in limited Quantities.

This is repudiating theory nearly altogether, and depending almost entirely upon the materials facts are to present us with in our progress; the only thing we borrow is the force of attraction reciprocally operating between electricity and common matter, it being to its presence in the old theories that we ascribe the measure of efficiency they are found to possess. In thus reducing assumptions to a minimum, it will, of course, devolve upon us to show that the single one remaining is competent for the duty thus thrown upon it, without claiming toleration for anything in addition that is inconsistent with observation, with our previous knowledge of nature, or with the principles of mechanical philosophy. We are undertaking to show that competence; and we are confident of proving successful; if it be only allowed us to make use of facts read in their unperverted language, and to require that what all may see every one shall believe.

11. The student may at once gain an insight into the principles upon which our single assumption is to do much of what is required of it; we have seen that, to have wherewith to account for the antagonism of force observed in electrical experiments, the old theories invented electrical repulsion, and thus set an antipathy of the particles of electricity for one another against their attraction by common matter which tended to keep them together; that this repulsion fell short of affording the full explanation it ought to have done can only be accounted for by alleging it to be an artifice representing nothing that has a natural existence. We substitute for it no second force, but simply a limitation in the electrical attraction included in both those theories, and which, when thus limited, is brought to *antagonize with itself by acting from opposite directions*. Its sufficiency, as thus modified, will result from successive demonstrations.

12. We shall want apparatus; and, as we expect to have many pupils in the provinces to whom philosophical instrument makers are not very accessible, and a still greater number everywhere, who either from motives of economy, or for the sake of the manual dexterity to be acquired by so doing, will wish to construct their own, out of materials and with such assistance as are for the most part generally at hand, we intend to give from time to time some engravings and suggestions that we think will be useful. But as we hold that no pursuer of knowledge will like to be baffled by default of his apparatus, we shall not hesitate on any proper occasion to indicate what is reliable, even though it may be necessary to obtain it altogether, or in great part, from the professional makers.

(*To be continued.*)

THE AUTOMATIC TELEGRAPH OF THE ABBE CASELLI.

THE systems of telegraphic transmission in actual use are limited to a code of signals representing the letters of our alphabet, which happen to be the same or similar to those employed in several other languages of continental Europe. Nevertheless, when a message is to be received in a foreign language, it is ne-

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cessary, in order to prevent mistake, that the *employé* should be well acquainted with the language in question. However considerable might be the collective acquirements of a staff of telegraphists, it is probable that a missive couched in Hebrew, Arabic, or Sanscrit, might be the occasion of considerable difficulty in translation and re-translation before its transmission to a distance could be effected. We do not here allow that the word "impossibility" should interfere with the legitimate employment of the electric telegraph. But what could we say to the antiquary who, in hot haste to discover some hidden meaning, should bring to us the hieroglyphics from an ancient tombstone for transmission to some distant CHAMPOLLION—intelligible to him alone? Should we not have to refuse also the *naive* request of the young lady with the piece of music, a *sonata* or an *aria* for her dear friend at St. Petersburgh. And this poor man, defrauded to the extent of some few thousands by the absconded delinquent whose unmistakeable portrait, sketched in outline from the heliograph, he presents for immediate transmission to the Belgian police authorities! Certainly here we should have to confess the present limits of our telegraphic art; which can transmit to a distance intelligence and thought expressed in words, represented by the letters of our alphabet, but not any *gribouillages* that can be made upon paper or metallic foil. But we might also bring to mind that, many years ago, an English inventor of the name of BAKEWELL, proposed a system for transmitting autograph communications, which also was applicable to the reproduction of anything that can be inscribed upon paper. In connection with the subject we might also remember the name of M. LUCY FOSSARIEU, and, of late, we should have heard of that of the Abbé CASELLI, the inventor of the *Pantelegraph*.

Few of our readers would require to be informed that, by means of a telegraph wire and an accurately synchronous clockwork movement at two distant stations, it is both possible and easy to reproduce, with mathematical exactitude, the characters which may be traced at the transmitting station with a non-conducting material upon a conducting strip of metal in connection with the line wire. Providing the conditions as to wire and synchronous movement remain perfect, the arrangements to this effect are sufficiently simple. A metallic point connected with the battery transmits the current through the conducting strip of metal and to the line wire, so long as the circuit is not broken by the contact of this metallic point with the lines traced in insulating ink. At the receiving station a chemical change is produced by the electrical agency upon a prepared strip of paper, traversed by a metallic point in connection with the line wire. At each interruption of the current, the chemical action, which causes a coloured line to be traced upon the paper, is arrested. The synchronous movement of the metallic foil, and of the prepared paper, causes the effect of each interruption, occasioned by the insulating ink upon the former, to be produced upon the latter when the two stylets are in exactly the same relative position in regard to the surfaces which are respectively traversed by them in a series of lines in close proximity to each other. The characters are therefore reproduced in white upon a coloured ground. The result is sufficiently wonderful, occurring as it does with great rapidity, to have awakened the admiration of the special correspondent of the *Times* at Florence, and to have occasioned the encomiums bestowed upon the Italian inventor by the EMPEROR of the FRENCH. But the system is by no means new; and we believe originated with our own countryman. It is stated that the arrangements of the Abbé CASELLI for securing isochronism, by means of the vibrations of two pendulums, are peculiarly perfect; but it is not asserted, on the other hand, that those of Mr. BAKEWELL were defective. The complete success of the experiments which were made at Florence appear to have been due, in a great measure, to the perfection of the instruments constructed by M. FROMENT; but we have little doubt that, without interfering in any degree with the points of novelty which may be peculiar to the *Pantelegraph*, our HENLEYS ELLIOTTS, and BRITTAINS might vindicate at the forthcoming International Exhibition our claim to an invention which, whether applicable or not in a practical point of view, is justly regarded as one of the most beautiful applications of electrical science.

THE LISBON TELEGRAPH.

CONSIDERABLE discontent has recently been exhibited owing to the delays that have occurred in the transmission of telegrams to Lisbon; and we share in the surprise that has been created at the announcement that it takes *four days* to send a message from Liverpool to the Portuguese capital. Messrs. SAMUEL JOHNSTON and Co., of Liverpool, state that a message sent by them on the 11th of November, was not received by their correspondent in Lisbon till the 14th; while a message despatched to them from Lisbon on the 29th December was not to hand till January 3rd. This is only one of a great many cases that have been reported to us, and for the credit of the telegraph service we trust that such delays will be strictly investigated.

From Messrs. JOHNSTON'S statement we are led to believe that they have not been allowed to pass wholly unnoticed. The Magnetic Company have rendered "every assistance in their power," and state that the fault is with the Portuguese authorities. So it may be; but may not they in their turn say the fault is in England?

Our opinion is that no delay occurs in England. The telegraph companies here are organised by responsible men, who know that the dividends depend in a great measure upon speed. In fact, according to Messrs. JOHNSTON, the Secretary to the Magnetic Company, has repudiated any share in the delay. It remains now for us to hear what the Submarine Company have to say in the case, and whether it is in their power to state to what point on the way to Lisbon the public may rely upon a message being promptly and accurately despatched.

It would also be satisfactory to know whether the continental agreements of the latter Company will enable them to induce the Portuguese authorities to make other arrangements, or if the Governments of the two countries can interfere to the public advantage. It is obviously ridiculous for the commercial public to pay down five pounds for a message which, according to the views of the foreign authorities, will answer its purpose if it reaches its destination "sooner than if sent by post."

We have taken up this question as one affecting the telegraph interests. It is not to Lisbon alone that these delays occur. Messages are now allowed two days to reach Alexandria; ample time surely, yet it has frequently proved insufficient to catch the outward mail. Again, we ask, where does the delay occur?

It is not difficult to understand that during the day messages may accumulate to a great extent, and that delays occur as the pressure arises, but during the hours of the night the telegraph operators can reduce the number on the list considerably; and it is out of all question to suppose that, with the power of instantaneous signals from London to Taganrog, we can rest content to pay five pounds to send a telegram, when, on the payment of at the most a couple of shillings, the same despatch would be received almost as quickly "if sent by post."

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 124.]

THE axiom acknowledged by most electricians, that equal quantities of electricity must in all cases be produced, and that it is impossible to annihilate any portion of one of those quantities without neutralizing an equal quantity of electricity of the opposite nature, has been, in these received explanations of the action that takes place when the conductor in connection with one side of a source is connected to earth, and indeed in the explanation

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of nearly all the electrical phenomena, apparently lost sight of; for if we allow and bear in mind these two fundamental axioms, testing each new position by them, we must arrive at very different views of the various actions which take place, the present received explanations being positively contrary to these axioms.

To show that these axioms are, to a certain extent, admitted by the most eminent writers on the subject, I quote a few passages: thus—

Professor Daniell says, "Chemical Philosophy," p. 245: "We have seen that one electric force cannot be produced without an exactly equal development of the other; and upon more attentive examination we shall find that no kind of matter, either conducting or non-conducting, is capable of receiving a charge in any way of one kind of electricity independently of the other, or without calling forth an equal amount of the opposite force in adjacent bodies."

But, moreover, Professor Faraday observes, "Researches in Electricity," vol. i. p. 367: "As far as experiment has proceeded, it appears therefore impossible either to evolve or make disappear one electric force without equal and corresponding change in the other."

Now it follows from these laws, if correct, that where a conducting surface is charged with one electricity, an equal quantity of opposite electricity must in every case be produced, and that as long as this first quantity remain in existence, an equal quantity of opposite electricity must remain in abeyance and in existence, and that no portion of the one can be destroyed without neutralizing an equal portion of the other.

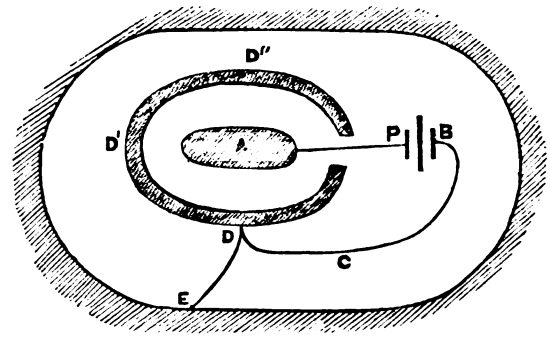
When, therefore, a given quantity of positive electricity is generated by a source, so as to charge a conductor, an equal quantity of negative must be produced and conveyed somewhere. According to the explanations I have quoted, it would go to the common reservoir, the earth, and be distributed over its surface, and thus be virtually annihilated. When the charged conductor is connected to earth its electricity would also flow to earth and distribute itself over its surface, and we may allow thus far, that since equal quantities of opposite electricity would thus be imparted to the earth, and each "virtually annihilated," equilibrium would at this stage of the action be restored by recombination, and the axiom of equality of change in both states is thus somewhat clumsily complied with; although this fulfilment of the fundamental axioms is in none of the published explanation, thus pointed out or insisted on. For it will be seen that, according to the received explanations, the negative electricity in this case would be disposed of at once, and for ever, by "virtual annihilation;" and afterwards any other electricity that remains, such as the positive charge on the insulated conductor, is likewise disposed of in a similar manner; but in no place is *absolute neutralization* by *recombination* mentioned, so that these writers were evidently content to imagine that *either* electricity of *itself alone* could flow to earth, and be not only *virtually*, but (since it is never again alluded to) *absolutely* annihilated.

It will easily be seen, therefore, how these explanations clash with the above axioms, and at the same time the clumsiness and imperfection of the whole theory based on the size of the earth, will, I believe, be easily allowed.

That it is erroneous to suppose that either the negative electricity generated on connecting the negative pole to earth, or the positive charge on the conductor A, go to earth and are diffused in the least over the surface of the earth, I maintain, and will endeavour to prove.

Now if the negative side B of a source, instead of being connected to earth were connected to a conductor DD'D'', closely enveloping the prime conductor A attached to the positive side P of the source, we should recognize in such an arrangement nothing more than a Leyden jar, the surface of the inner conductor A forming the inner coating, and the interior surface of the outer conductor D D' D'' forming the outer surface.

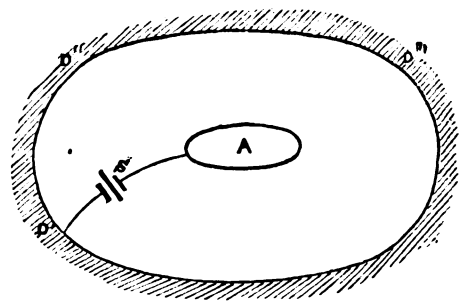
On these two surfaces practically all the electricity generated would reside, a very minute portion residing on the surface of the exposed connecting wires and the outer surface of D.



If the outer conductor were joined to earth by D E, we should never admit that the electricity on this outer conductor divided itself with the surface of the earth, for then practically all the charge on the *interior* and exterior of this conductor D D' D'' must flow to earth and be virtually annihilated, which we know it will not.

A certain minute portion of electricity resident on the exterior of D D' D'', and on its wire D C B, would, it is true, flow through D E, but that this even would not flow to earth, but to the surrounding surface, will be easily seen as we proceed.

If now, instead of having the source S exterior to the outer conducting surface D' D'' D''' we place it between the two opposing



conducting surfaces to which the two sides of the source are connected, so that not even the connecting wires shall be exterior to the outer surface D' D'' D''' we obtain conditions which must cause the most absolute and rigidly equal division of the two separated electricities, the one all on the exterior surface of A, the other on the interior surface of the outer opposing surface D' D'' D'''.

In such an arrangement there can be no possible tendency for the separated electricity distributed over the outer opposing surface to flow to earth.

With such a view of the case, the outer opposing surface retains always a quantity of electricity exactly equal to that on the inner surface, and these equal and opposite quantities are only "annihilated" by *recombination* when the inner surface is connected by a conductor to the outer one, or as it would be termed when "the insulated conductor is touched to earth." The two opposite and equal charges being allowed by conduction to *recombine*, they *neutralize one another*, and all is reduced to the normal state.

It is not necessary to the view I thus take that the two conducting surfaces in connection with the two sides of the source be directly opposed to one another; on the contrary, they may be opposed in every direction to the two surfaces of an intermediate conductor, or to the surfaces of several intermediate conductors, or again partly directly opposed to one another, and partly to the surfaces of an intermediate conductor in a variety of ways, which will be pointed out when progressing regularly to discuss accumulation with this view.

It is difficult to embody in a few words the entire summing up

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of all these cases, so as to take the form of an enunciation, the following will be however tolerably correct.

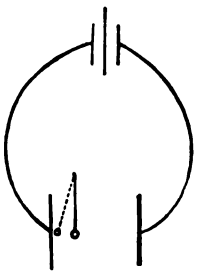
When the separation of electricity occurs by accumulation, the accumulation takes place on those surfaces of the conductors, in connection with the two sides of the source, which bounds the dielectric separating those conductors, either directly from one another, or from some third or several conducting surface or surfaces.

Most electricians admit, it is true, that an opposite and equal electrical state to that of the prime conductor is called forth in the surrounding conducting surface, but this is termed induced electricity, and we are called on by the theories I have quoted—first, to believe that the negative electricity generated by the source is first annihilated by distribution over the earth's surface, and then, that another quantity of negative electricity is called forth from the earth by induction and distributed on the surrounding conducting surface. No mention is made of what would become of the quantity of positive induced electricity thus set free or generated; which, if we hold the axiom of *equal generation*, ought to be accounted for.

With the view I take, it will be seen further on that, in every case of electrical generation, not only are the quantities generated directly from the source always equal; but that when any change in the electrical state of any other conductors separated by a dielectric from the source takes place, *equal quantities* of *opposite electricity* must also be produced. Or, in other words—firstly, all generated electricity is generated in equal and opposite quantities; and secondly, *induced electricity must always be called forth in equal and opposite quantities.*

That the negative charge in the case I have assumed is really as much resident on the interior surface of the surrounding conductors as the positive charge is on the interior, I offer the following arguments.

If an insulated and uncharged ball be suspended by a thread, and placed near one of two plates attached to the two sides of a



source of generation, on allowing the source to act, the ball will, it is well known, be attracted to the nearest of these plates, (no matter whether positive or negative,) and then repelled. Each plate is equally charged, and theoretically, if the ball were placed exactly in the centre, it could be attracted to neither, since both attract with equal force; but being placed nearer to one than the other, the difference of the two forces is in favour of the nearest.

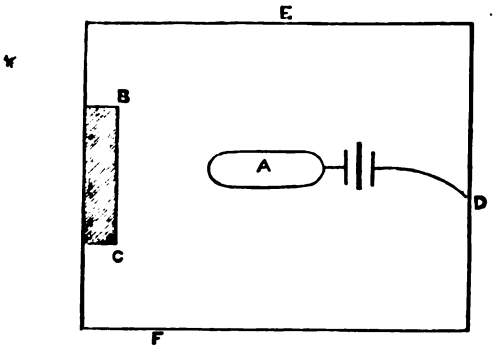
If a similar ball be brought near the prime conductor of an electric machine, and the machine set in motion, it will be attracted, and then repelled; and this is set down as a rule without reserve.

Now if my view holds good, then, since the walls of the room are themselves negatively charged, though to a very much lower density, there will be some distance from the walls at which, if the ball be placed, it will no longer be attracted *towards* the machine, as according to received views it should, but will be attracted towards the wall, and apparently repelled by the machine.

Such in fact occurs; the very great difference between the surface of the room and the conductor renders the degree of accumulation on the walls too minute in some cases to move the ball, considering that it is the *difference* of two forces which is acting. If, however, we move the machine to within two or three feet of the wall, so that the accumulation on the proximate part of the wall be somewhat increased, and place the ball at a distance of about half-an-inch from the wall, attraction towards the wall first, and then repulsion from it, will invariably take place.

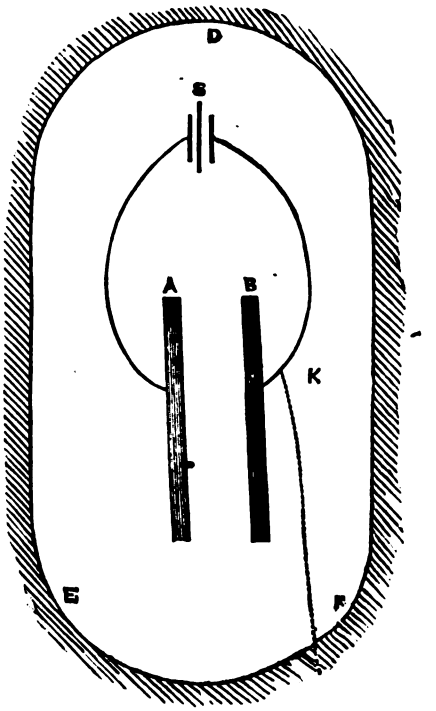
Again: it is possible to obtain electricity from the walls with the proof plane the same as we do from the prime conductor.

It may be argued that such tests do not prove the presence of negative electricity to be resident on the surface, because they amount, after all, to the same process on a diminutive scale as those by which we charge a conductor negatively, by "induction"



in its received sense. Thus: if A be a conductor charged positively by a source, the other pole of which is in connection with the surrounding surface D E F, then if B C represent a proof plane (exaggerated in size), brought into contact with the outer conductor, we should expect it to become negatively charged, though *not* from the electricity on the surface E D F, but by the received explanation that its negative electricity would be attracted towards A, whilst its positive electricity would be *driven*, or *flow* to earth, and be *virtually annihilated* by diffusion over the enormous surface of the earth.

Let us put this in another light. Let A and B represent two plates in proximity, connected to a source of generation S,



both insulated, and far and equally removed from the surrounding conducting surface D E F. Now the electricity will be principally accumulated on their proximate surfaces, and if we touched either with a proof plane, whatever electricity we brought off we

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should consider as having formed part of the charge resident on that conductor, and deposited on it direct from the source. Let us suppose we have taken negative electricity from B, having withdrawn the source. Now place B in connection with the earth by K F; very little difference will exist in the accumulation on B, and we may, by precisely similar tests, carry off another small charge of negative electricity. Yet this time we are, according to received theory, to believe that this is caused by a totally different action. The electricity originally generated at the negative pole has diffused itself over the earth, and by virtue of the size of the earth been virtually annihilated, and the conductor B, as it forms only a portion of the earth, only retains any charge on it by virtue of the proximation of A, which acting by induction repels the positive of B to earth, leaving B negative on its surface nearest to A. If A were removed this negative electricity of B must therefore flow back to earth, or else be neutralized by the positive electricity which has been diffused over the earth, *returning*. The proof plane is to be considered in the same light, its positive electricity is repelled to earth, leaving negative electricity on it. The action, according to my views, may be thus roughly stated: A and B are in the first case equally charged, and have induced certain *equal* quantities of opposite electricity on the surrounding conducting surface. When B is connected to this surrounding surface, all the induced *positive* electricity on the latter is neutratized by an equal quantity of negative electricity passing from B. The quantity on B is therefore less, and the density less, as shown by the proof plane. But the quantity of induced negative electricity remaining on the surrounding opposing surface is evidently just equal to the quantity which B lost by neutralization (since this was neutralized by the positive induced electricity, equal to the negative induced electricity).

The quantity of negative on the surrounding surface, and the quantity of negative on B, will, therefore, together equal the positive of A, still leaving, therefore, *equal quantities of electricity in opposition.*

(To be continued.)

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 126.]

A cable made by Mr. Hooper was submitted after our experiments were concluded, and we had no opportunity of testing it. The strength is given by steel wires laid on in a slight spiral, protected from corrosion by means of vulcanized india rubber.

The results shown in the above table for Mr. Allan's cables are remarkable. In these cables the strength is given by steel wires laid spirally round the copper conductor, thus using the strength giving material to form part of the conductor; the area of the conductor is, therefore, increased; and there is no danger of the conductor knuckling through the gutta percha from the resiliency of the latter. This addition to the conducting area increases the induction of the cable in the full ratio of the increased area, but it only increases the conducting power of the cable in the proportion which the conductivity of steel bears to that of copper, which is about one-seventh. To obtain the same capacity for the transmission of messages in a cable of this kind, as in a cable in which copper forms the sole conductor, the dimensions of the conductor must be increased to give the same ratio of conduction to induction. The insulating material of course requires protection in these as in other cables.

All the cables in the table in which iron is used for strength have been furnished with some protection against corrosion. This is afforded in some cases by hemp, in another case by tape, shellac, and marine glue, in another by india rubber and india rubber canvas, in another by a mixture of cocoa-nut and gutta percha covered by india rubber canvas.

In the cables in which hemp is used for giving strength, the hempen strands have been protected in one case by a serving of hemp, in another by a combined covering of hemp and iron wire, and in another by a sheathing of copper. The object of employing copper being, that it is not so subject to corrision in the sea as iron.

We consider it essential that in iron or steel covered cables the iron or steel should be protected against corrosion, both as a preservative before laying and as a security when laid, to enable them to be raised in case of injury. The protection of the iron or steel covering by hemp alone cannot be durable; nor, indeed, are we satisfied that any of the materials submitted for protecting the iron or steel covering would be durable if exposed to abrasion. It has been suggested that for cables in shallow water where a solid covering is wanted, the outer covering should be sought in some hard metal not acted on by sea water—probably some alloy. We believe that a coating of tin upon steel or iron wires, with a further protection by means of hemp saturated with tar or some more durable compound, or covered with a cheap form of gutta percha would be advisable. Cables in which the strength depends on hemp will not be able to be raised for repairs, and unless the hemp is protected, will be subject to destruction by marine animals and vegetation, by decay, and by abrasion on hard surfaces. The durability of hemp, however, may be much increased by coating it with some compound of gutta percha or with marine glue. Whatever, however, be the outer covering, it should prevent any strain being brought on the inner core; the specific gravity should, therefore, be adapted to the depth and be such as to ensure the cable sinking evenly. We understand that the specific gravity of the Toulon and Algiers cable (1·9) recently submerged in depths of from 1,600 to 2,000 fathoms has proved satisfactory in practice. It is also to be observed that the necessity for joints to be made in a cable whilst laying and after it is laid down is sure to occur, and must be provided for. The difficulty of making a joint even in gutta percha wire has already been alluded to, and whatever be the outer covering, it is evident that it will often be found necessary to make joints in it at sea under circumstances of considerable difficulty. In the ordinary twisted cable a splice can be made almost as secure as the original cable. Longitudinally covered cables will necessarily present greater difficulties, and the fact that joints will have to be made must be borne in mind in the selection of the outer covering of a cable. When three or four wires are included in the same covering, a defect in any one of the wires renders it necessary to cut the entire cable, and this difficulty is no doubt an objection to this kind of cable.

4. *Laying and Maintenance of Submarine Cables.*

We have only incidentally considered the question of laying submarine cables.

All the evidence which we have collected on the subject tends to show that no cable should be laid without detailed survey being previously made of the bottom of the sea where it is to be laid, in respect both of the irregularities of the surface and of the material of which the surface is composed. These materials should be subjected to analysis, to ascertain whether they are likely to produce any chemical action detrimental to the cable, and the course in which the cable is laid should be selected with a view to avoid, as far as possible, any bottom upon which either mechanical or chemical injuries are to be apprehended.

The Channel Islands telegraph, to which we have already alluded, affords a strong instance of the necessity of such a survey. The Red Sea telegraph, which has been entirely corroded where it lies over the Dhalac Bank, is another; the Bona and Cagliari cable, in which corrosion and fracture have occurred in deep water, is another; and the Cagliari-Malta telegraph, where the failures have occurred in comparatively shallow water, on a bottom strewed with rocks, or, as some persons have suggested, subject to volcanic action, is another.

Any ground liable to anchorage should be carefully avoided, and also water so shallow as to be affected by surface currents, yet whenever it is practicable the depth should not be greater than to allow the recovery of the cable and its repair when necessary. It has been found almost impracticable to recover cables that have been laid in greater depths than from 300 to 400 fathoms, nor, except in very rare cases, have any under water currents been found to exist beyond a depth of from 60 to 100 fathoms. This, therefore, should form a criterion of the depth to be selected, provided such depth and a favourable bottom can be found. Silt or mud has in some cases been found to corrode the iron covering of cables very rapidly, in other cases to preserve them, according to the constituents of the mud. All uneven, rocky bottoms should be avoided, especially in the neighbourhood of volcanic action. The surveys that have been made have been far too superficial in this respect. It has very properly been observed that if the land between London and Brighton were under water, and were surveyed from the surface at distances of ten and fifteen miles only, the soundings might accidentally so occur as to indicate nearly a level bottom, whereas we know how undulating the country really is. So important is the selection of a proper site for a cable that soundings should be taken at least every two or three miles, and much more frequently when any great irregularity is indicated by those soundings. In this way dangerous

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reefs and precipitous spots might be avoided, and generally, with but little diversion, favourable ground might be found.

We trust that no telegraph cable will be laid in future until the best course has been selected by detailed investigation of this nature.

With respect to the mechanical operation of laying, we believe that many improvements have yet to be made. The first requisite is that the ship should have a large amount of surplus power, so as to be able to make way against contrary winds and seas.

(To be continued.)

THE ELECTRIC TELEGRAPH IN RUSSIA.

[Continued from p. 128.]

The submarine line would therefore connect Kamtschatka with America, *i. e.* the Old with the New World; but in order to completely encircle the world, it would have to be extended on one side as far as California, and on the other to the Amoor, where all the Russo-American lines meet.

From the Island Aliaska an aerial line could be erected as far as the Russo-American colonies; but in the other less populated countries, inhabited by wild and warlike tribes, the construction of such lines would be scarcely practicable, unless they could be properly protected.

The same objection applies to the English colonies of the Hudson's Bay Company, and further, also, to Oregon and California, and for the same reason it was found necessary by the Anglo-American Company to construct a submarine in preference to an aerial line between San Francisco and Vancouver's Island.

Submarine cables can, in the same manner, be laid between Kamtschatka and Aliaska, connecting the islands of Schumagine, Kardiak, and other small ones, as far as the port of New Archangelsea, on Sitka, and down to the Island of Reine Charlotte.

The length of this line would be 1,315 miles (2,300 wersts), and it would be connected with the cable which is already laid between Vancouver and San Francisco, thus establishing a communication with all the telegraph lines of America.

A submarine line between Kamtschatka and the Amoor would therefore be also preferable to aerial lines, having the latter only when urgent necessity requires.

There are four routes for such a line, viz.:—1. Ochotsk; 2. Bolcherezk; 3. Sachaline; 4. Japan.

I. With reference to the first route, it would be likewise necessary to connect this line by small sectional cables, as an aerial line along the shores of the Sea of Ochotsk, as proposed by some engineers, would be impracticable, the country round the Sea of Ochotsk being wild and uninhabitable.

Starting from Nicolaevske on the Amoor, this line to Kamtschatka would have to touch at the following points:—

	Wersts.
1. The Bay of St. Nicolai, in Ulbon (aerial line) ...	200
2. The Chantar Islands (submarine cable)	200
3. Port Ajan (do.)	275
4. Ochotsk (do.)	500
5. Port Tauisk (do.)	425
6. Cape Piaguine and Iamsk (do.)	500
7. Tigel, in Kamtschatka (do.)	175
8. Nischne Kamtschatka (aerial line)	425
Total	2,700

There would only remain to be constructed a length of 275 wersts, including 105 of aerial line, from the southern part of Kamtschatka to Behring Island. The submarine line from Kamtschatka to America would therefore have to start from Cape Kamtschatka and Nischne Kamtschatka, and not from Petropavlovsk, but be connected with the latter by an aerial line of about 725 wersts from Nischne Kamtschatka.

The line *viâ* Ochotsk would therefore be of the following length:—

Submarine cable	2,075 wersts,	or 1,187 miles.
Aerial line	1,350 „	771 „
Total	3,425 wersts,	or 1,958 miles.

II. Route *viâ* Bolcherezk:—

	Wersts.
1. From Port De Castries to Cape Lasareff..... (aerial line)	110
2. Straits of Sachaline ... ... (submarine cable)	10
3. Bay Nü, on the east shore of the Island Sachaline (aerial line)	130
4. Bolcherezk, in Kamtschatka... ... (submarine cable)	950
5. Port Petropavlovsk ... ...(aerial line)	200
Total	1,400
or 800 miles.	

III. Route *viâ* Sachaline:—

In connection with an aerial line as far as Cape Terpenia, a submarine cable of 550 wersts (315 miles) would be laid to the Russian island Urup (Curilian Islands), and meet the line leading to Petropavlovsk.

The length of this line would be 2,800 wersts (1,600 miles), including an aerial line of 914 wersts, or 1,200 miles.

IV. The route *viâ* Japan:—

From the Bay St. Olga to the Port of Hakodate, on the Japanese island Matsmai.

A submarine cable, of 600 wersts, or 350 miles, which, following up the line in the direction of the Curilian Islands as far as Port Petropavlovsk, in Kamtschakta, would form a length of 2,500 wersts, or 1,422 miles.

The different lengths of the line by these four routes, taking Habarovska on the Amoor as a central point, would be as follows:—

	Aerial line.	Cable line.	Total miles.
1. *Viâ* Ochotsk	1,272	1,116	2,548
2. *Viâ* Bolcherezk	622½	542½	1,171
3. *Viâ* Sachaline	914	1,057	1,971
4. *Viâ* Japan	402	1,428	1,830

It will be observed that the first three routes pass through Russian territory; the last route from Hakodate, along the Curilian Islands, Matsmai, Kunaschir, and Urup, which being Japanese possessions, it would, in a political point of view, appear inconvenient, but, as regards commercial interests, it would prove advantageous, Hakodate being a port used by the whole European commerce.

The route *viâ* Bolcherezk being the shortest and most convenient, and the depth and peculiarity of the Sea of Ochotsk presenting no obstacle to laying a submarine cable, and passing through more inhabited countries, preference ought to be given to this route over the others, provided that no unforeseen impediment should present itself.

The route *viâ* Ochotsk being much longer, and therefore more expensive, besides leading towards the north, where an aerial line of 200 miles would have to be constructed through a wild and uninhabited country, the erection of such a line would be impracticable.

Although the route *viâ* Sachaline is more southerly, yet it is too long, more expensive than that *viâ* Bolcherezk, and likewise more incovenient, as it leads through the wild steppes of the Curilian Islands, which are still uninhabited.

However, this line appears to offer some advantages, as it could be connected with all the Russian frontier points in the Pacific, yet it would by no means supersede that *viâ* Bolcherezk, which would require the following lengths of cable:—

	Wersts.	Miles.
From the Amoor to Kamtschatka	1,400	800
From Kamtschatka to Aliaska in America	3,282	1,875
From Aliaska to Reine Charlotte Island	2,300	1,315
Total	6,982	3,990

Or about 7,000 wersts, or 4,670 English miles, or 1,000 German miles, or 4,000 nautical miles.

Instead of the aerial lines through Sachaline and Kamtschatka, underground lines would perhaps have to be substituted, owing to the wildness of that part of the country. These underground lines would therefore have to be considered as cable lines.

TELEGRAPH TO CHINA AND JAPAN.

The aerial line through Siberia, which the Russian Government is at present constructing, leads to Japan and China, and offers the quickest communication with Europe. Messages from Japan can be sent from Japan to the Russian ports of Wladivostock and St. Olga, which are situated in the Sea of Japan, and thence telegraphed *viâ* Siberia to London and Paris and the whole of Europe. Messages from China, sent through the Russian Post-office from Pekin to Kiachta, can be telegraphed from the latter place to all parts of Europe.

If the commercial interests of Europe should require it, a direct telegraph, either submarine or aerial, could be constructed to Japan and China, in connection with the Siberian line. A land line would have to be erected in the direction of Kiachta.

There are several routes from Kiachta to China through the desert of Gobi, but the one which is at present used by the Russian post traffic would have to be chosen for the construction of a land line, forming a length of 1,775 wersts (1,015 miles), through one-half of this—viz., from Urga to Kalgan, a distance of about 1,285 wersts (735 miles)—is a woodless, stony and sandy tract of land, and only

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inhabited by nomadic Mongols, who relieve each other at the post stations; yet there would be no difficulty in constructing a telegraph line, as at certain places, where there are pasture grounds and water in abundance, stations could be erected for the men guarding the line. It would also be advisable to substitute iron for wooden poles, in case one or more of the poles should in time become useless, as wood in this part of the country is very difficult to procure.

However expensive such a land line would be, it deserves mature consideration whether the vastness of the commercial interests of Europe would not warrant such an outlay, as the want of wood for building purposes, the expense of supplying it, the erection of stations in the desert, and the supply of other necessaries, would increase the expense by 500 roubles (about £80) per werst, which would amount for the whole length of the 1,775 wersts of land line to 900,000 roubles, (3,250,000fr., or £130,000.)

But as regards a submarine telegraph to China, the first connecting point with the Siberian line would have to be at Shanghae, the port most frequented by China-European commerce, from which place alone, the messages transmitted to Europe would be so numerous that the expense of such a cable would in a short time be covered by the traffic.

From Shanghae a branch aerial line to Pekin could be constructed, but the erection of such a line in the present disturbed political state of China would scarcely be practicable; and as regards the length of a submarine line thence to the shores of the Bay of Petshelig, it would, according to the indication of the map (to which we can only refer), be about 1,100 wersts (630 miles), the expense of which would be about 1,375,000rs.

If, on investigation, it should be found that a submarine line in this direction offers no difficulty, the expense of the whole telegraph line from Kiachta, in Siberia, to Shanghae, and thence to Pekin, would amount to 2,300,000rs. (8,300,000fr., or £330,000).

If, on the other hand, any political obstacle should prevent the carrying out of this line, it could be connected with the Russian ports at Shanghae.

From the future telegraph termini of the Siberian line at the ports of St. Olga or Novgorodsky, towards Shanghae there are several small islands which could be used as resting-points for the cable, and as stations; they lie, besides, near Japan, so that a branch telegraph line would connect Japan with the main one. The length of this cable line between the Russian shores and the Sea of Japan would be as follows:—

From the Port of Novgorodsky, Gulf d'Anville, to—

The Island of Dagelet	300	miles
„ Tsussima	180	„
„ Quelpart	180	„
„ Shanghae	300	„
From the Island of Tsussima to Nagasaki, in Japan	120	„
Total	1,080	

1,200 nautical miles: 2,100 wersts, which would cost about 2,500,000 roubles (9,000,000 fr., £360,000).

The length of the whole line between Shanghae and London would therefore be:—

The length *viâ* Kiachta, in Siberia, to Pekin, 12,000 wersts, or 6,860 miles.

The length *viâ* the Sea of Japan and the Islands of Tsussima or Quelpart, about 14,650 wersts, or 8,370 miles.

But as the telegraph line to the East Indies through the Mediterranean and the Red Sea, as projected by the English, forms a length of about 19,000 wersts, or 10,860 sea miles—viz., 4,000 miles more than that *viâ* Kiachta, the latter being the same length as the line between the Amoor and the Island Reine Charlotte, the same amount of capital as that expended on the East Indian line would suffice for the universal telegraph connecting the East Indies with Shanghae, and thus establishing a telegraphic communication between Europe, America, China, and Japan.

From the above we may conclude what material advantages would accrue from communication with the East *viâ* Russia.

THE EAST INDIAN TELEGRAPH.

As the English can make no use of the Red Sea cable, they propose now to construct aerial lines through the wild and barbarous countries of Asia Minor and Persia, and thence to Beloochistan and Affghanistan. Although the carrying out of such a project may be successful, yet the maintaining of such a line in a state of repair would be equally expensive as difficult.

But if a general telegraphic communication with the East Indies should crown such an undertaking with success, a glance at the map of Russia would convince one that the Russian telegraph line along the Caspian Sea, Orenburg and Ormsk, can very easily be extended to Teheran, the shores of Syr-Darja, and the Sea of Issik-Kul; and that, in case of any political misunderstanding, the short line between the Russian and Indian frontier stations could easily be destroyed.

Russia having no commercial relations with the East Indies would gain no other advantage but the transit of messages from such a telegraphic communication.

This route to the East Indies, which in every respect is a safer and better one than that through the wild steppes of Asia Minor and Persia, cannot be too strongly recommended.

I shall on some future occasion point out more minutely the telegraphic route between Russia and the East Indies.

(Signed) D. ROMANOFF,
Lieutenant-Colonel, Chef des Telegraphes.
Siberie Orientale.

TELEGRAPHIC COMMUNICATION BETWEEN ENGLAND AND IRELAND.

[From the OBSERVER.]

IT is not generally known that, in order to receive the news brought by the American packets as they touch at Queenstown, it is necessary that the despatches should be forwarded by telegraph a distance of nearly 800 miles, or about one-half of the entire length of the cable which for a short time stretched across the Atlantic. When the steamer calls at Queenstown its news has to be transmitted from Cork to Dublin, thence to Belfast, thence to Donaghadee, across the Channel to Portpatrick; from thence to Dumfries, then to Carlisle and Liverpool, and finally to London. This involves great delay, and numerous breaks in the communication, and mistakes constantly arise from these repeated transmissions. This, however, is by no means all the delay. The steamers call off what is called Roche's Point, and a steamer is now required to convey the despatches up the harbour to Queenstown, the time occupied being an hour and a half. Important as is the news required, there is no telegraph from Roche's Point to Queenstown. It is now proposed to establish a new telegraphic line, which will place Queenstown not only in direct communication with the telegraph station at the entrance of the harbour, but also with the old Head of Kinsale, from whence the Atlantic steamer may be sighted several hours earlier than is at present the case. Lord Fermoy has given permission to lay a telegraphic wire over his property from Roche's Point, which will be carried on to Queenstown, and join a main line, which will connect Cork and Queenstown with Waterford and Wexford, and thence run to Carnsore Point, projecting a considerable distance into the St. George's Channel. At this point the line will be submerged to St. David's Head, on the Welsh coast, and be continued through Milford, Gloucester, and Bristol, direct to London, the whole line being about half the length of that at present required to connect Queenstown and London. At Kinsale Head there will be a semaphore to communicate with vessels in the Channel. The Government have entered into arrangements with the promoters of this line to connect the Tuscar Rock Lighthouse with the main land at Carnsore, six miles off, and also to connect the Bishop Lighthouse, off St. David's Head, with the Welsh coast, three miles distant. These lighthouses sight each other across the Channel, from these stations vessels passing up and down the Channel will be immediately reported through the proposed line, and the lighthouses will be placed by means of the telegraph in direct communication with the life-boat station at Carna. Negociations are pending with the Government for the rent of one of the wires on the telegraph. The submarine portion to be connected is not more than fifty-two miles, and the cable will be constructed by Messrs. Silver and Co., of Silvertown. The conducting wires will be coated with india-rubber—the substance which was first used in submarine telegraphy, and to which, after many failures of other materials, scientific men are now again reverting. The land portions of the line will be constructed upon greatly improved principles; the poles, instead of being placed singly, as is now the case, will be erected in pairs, for the purpose of giving additional strength for supporting the wires. The pairs of poles will be at least a hundred yards apart, and there will consequently be much fewer points of contact with the earth than in the system of aerial telegraphs now in use, and a decrease in the amount of loss consequent upon imperfect insulation. This loss will be still further provided against by the use of the ebonite insulators of Messrs. Silver and Co., instead of those of porcelain or glass. The electrical arrangements connected with the submarine portion of the line are placed under the immediate control and direction of Professor Wheatstone. The line will, it is stated, be open early in the spring, and its maintenance is guaranteed for a term of years by the contractors.

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The Student.

THE following communication, from a practised hand, will be of value to those who are commencing the study of electro-metallurgy :—

Sir,—May I be allowed to insert a few practical instructions for electrotyping, for the use of those students whose interest in the matter has been excited by your *short* and *theoretical* paragraph on that subject, in the number, dated January 10.

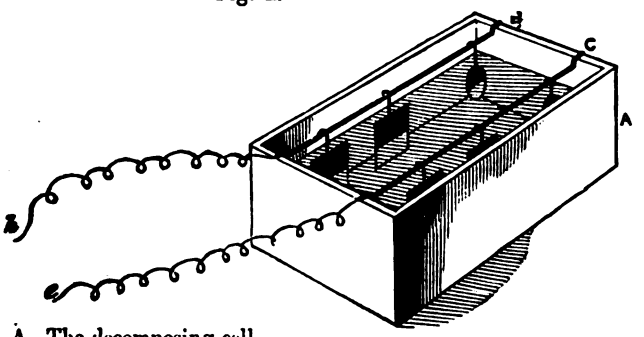
1. *The Battery.*—This is a most important point, for without a good constant battery the process will not succeed.

For a battery jar, any brown or white earthen vessel, such as a preserve jar, will do. For the porous pot, one made of thick, close sail-cloth of two or three thicknesses, tightly sown, may be used; or, what is much better, one made in plaister of Paris, according to the excellent instructions given in No. 4, page 42. Of course the height of the porous cell must depend upon the height of the outer or battery cell, but the internal diameter should be about 1½ inch. A slip of amalgamated zinc 1¼ inch broad, and as long as the porous cell is high, must be placed in it. Round the outside of the porous cell, half way between it and the battery cell, must be placed a cylinder of copper, which may be very thin, and the student may make it for himself; the different parts of the battery may be better understood by him if he can refer to figs. 1 and 2, pages 42 and 43; but he must remember that the metallic elements of this battery are to be in exactly the contrary position to what is there represented, viz., the copper is to be *outside*, and the zinc *inside*, the porous cell.

If the student commence his practice of the art by electrotyping small articles, such as plaister of paris medallions, about one or two inches in diameter (doing one or two at a time), he will find that one cell of the battery which we have recommended, if about 3 or 4 inches high, will be quite sufficient for the purpose; but if he wants to do any large article, or a number of small ones, he must use a battery of larger surface, *i. e.*, several cells connected as a quantity arrangement. In order to charge this battery, the porous cell must be filled with diluted sulphuric acid, and the outside cell must be filled with crystals of sulphate of copper, and then water is to be poured in to fill up the vacant space.*

2. *The Decomposing Cell.*—A wooden box may be made to answer for a decomposing cell, as well as a more expensive article of glass or porcelain, but in order to render it water tight it must be pitched inside; this may be done thus :—Place the box on the hob of the fireplace to get quite *hot* and *dry;* while it is heating melt some mineral pitch in an iron ladle or spoon, then pour the hot pitch into the box, and turn the latter about, so that the pitch may flow evenly all over the inside, and then pour out the excess from one corner; as soon as it is cold the box will be found to be perfectly water tight. Now, two thick brass rods must be placed across the top of the box, from one of which the moulds are to be hung, and from the other pieces of copper of the same size as the moulds. See fig. 2.

Fig. 2.



A. The decomposing cell.

B. The brass wire with moulds hung on it.

C. The other brass wire showing the wires proceeding from it suspending the copper plates.

D and E are wires proceeding from the battery.

The solution to be poured into this cell may be made thus :—"Dissolve in hot water as much sulphate of copper as it will take up, and add thereto three ounces of sulphuric acid diluted with a quarter of a pint of water for every pint of the copper solution employed."—WYLDE.

* If the porous sail be made of sail-cloth, it is advisable to have the solutions in it, and the surrounding cell, of nearly the same height, for if this is not the case the higher of the two would probably percolate through the cloth into the lower, and either deteriorate it or spoil it altogether; but if the porous cell be made of plaister of paris, or of porous earthenware, it is not by any means so *essential* to have them of the same height.

3. *The Moulds.*—If the object to be copied is in plaister, a mould of it may be prepared thus :—Place the plaister impression in a plate of water, so that the water may not come up over the surface; while the plaister is soaking melt some wax in a spoon or clean ladle, and add to it some Venice turpentine—more must be added in cold than in hot weather; as soon as the wax is nearly ready, remove the plaister from the water and quickly wrap round the edge a strip of moist paper, and tie it with a thread; now pour in the wax, the cast thus made may be removed from the plaister in two or three hours. If the plaister is good the wax will come off "clean," but if not some of the plaister will adhere to it; if this happens, of course the plaister mould will be spoilt, but the wax cast may be "cleaned" by soaking it in diluted sulphuric acid, the particles of plaister may be removed when loosened by a brush.

4. *Finishing the Arrangement.*—In order to suspend the moulds conveniently, a piece of copper wire may be warmed and pressed into the back; the face of the mould must now be rubbed with black lead which may be applied by means of a soft tooth brush, the surface being breathed on to cause the lead to adhere; but no lead must be left in *lumps* in any of the fine cuttings of the cast. The lower end of each cast must now be weighted, by warming a piece of glass rod and letting it in in the same way as the copper wire was let in. The wire proceeding from the mould must be twisted round one of the brass rods on the top of the decomposing cell, and this rod must now be connected with the *zinc* plate of the battery. The pieces of copper are to be hung on the other wire, and this wire is to be connected with the copper plate of the battery. Of course care must be taken to cover the moulds with the solution in the decomposing cell. In a few hours the moulds will be covered with a deposit of pure copper, and in three or four days this deposit will be thick enough to be removed, and will be found to be a most complete copy of the plaister cast. The chief thing to be attended to is to get the copper deposited at the right pace, for if it comes too slowly it will be very brittle and crystalline, in this case the moulds must be brought nearer to the copper plates in the decomposing cell; or, if it comes too quickly, a brown powder will be thrown down, which will occasion a great waste of the solution, and cause the copper to be granular. In this case the moulds and the copper plates in the decomposing cell must be pushed further apart.

ELECTROTYPE.

[We cannot see what advantage is to be gained by reversing the position of the elements in the couple formerly described.—ED. E.]

(To be continued.)

ON THE DEPOSIT OF THE METAL WHICH TAKES PLACE FROM THE NEGATIVE TERMINAL OF AN INDUCTION COIL DURING THE ELECTRIC DISCHARGE IN VACUO.

BY MR. J. P. GASSIOT, F.R.S.*

WHEN the electrical discharges by an induction coil were made from platinum wires, hermetically sealed in a vacuum tube, as usually constructed, the wire which was attached to the negative terminal of the coil shortly assumed the appearance of being corroded. This arose from very minute particles of the metal having been disintegrated and separated from the wire, which particles were deposited on the sides of the tube, in a lateral direction. If the wires were protected within the vacuum, by being covered with glass tubing extending about an eighth of an inch beyond the wire, it was the inside of the tubing that became coated with metal; but exclusive of this lateral action, a portion of the regular discharge would be observed to obtrude from the glass tubing in the form of a luminous brush. This luminosity was very sensibly affected by a magnet, and could in this manner be made to impinge on different parts of the vacuum tube; and whenever it was thus impinged heat was always evolved. This phenomena of the deflection of the negative discharge was described in a paper communicated by him to the Royal Society, and as he was subsequently desirous to examine with greater accuracy the nature of the deposit thus obtained from the negative terminal, and particularly if it could be obtained in the same manner from other metals than platinum, he had an apparatus constructed in which the discharge could be in slips of glass. The apparatus was also so constructed that wires of different metals could be inserted, and in this manner he succeeded in obtaining deposits of the following metals, viz., gold, silver, copper, platinum, zinc, iron, tin, lead, brass, magnesium, tellurium, bismuth, cadmium, and antimony. For many of these he was indebted to Mr. Matherson. With gold, silver, platinum, tin, and bismuth, the deposit would take place in the state as then exhibited after about twenty-four hours' action. If the discharges were continued the deposit became denser, and the

* Read at the British Association, 1861.

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centre was crystalline. With reflected light a large surface exhibited the lustre of the metal; with transmitted light the outer portion was transparent, showing the peculiar colour of the metals, as, gold, green; silver, bluish purple; platinum and tin, blackish grey. Tellurium, with the exception of antimony, he found disintegrated more freely than the other metals, while iron and magnesium were the most difficult, the deposit of the latter being scarcely perceptible. With alluminium wires he could not obtain any deposit after forty-eight hours' constant action. On one occasion he observed a faint trace on the glass, but on repeating the experiment with another wire, no sign of any deposit could be obtained. Under the microscope the larger deposit of metal was not resolved into any form, but appeared as a mere film on the surface of the glass. From a brass wire terminal there was not any separation of the original metals. He had a tube constructed with two wires, both protected by glass tubing. A long slip of glass was inserted so that the discharges from the positive and negative terminals of the coil could be made with protected wires under the same conditions. The wires were of gold. The usual deposit took place at the negative, but after twenty-four hours' constant action not the slightest indication of any deposit from the positive wire could be observed. With antimony, a very peculiar effect was obtained. Instead of the metal being deposited in a circular form, it spread nearly all over the glass, and on the sides of the vacuum tube. He repeated the experiment by inserting slips of glass of sufficient length as to reach beyond the terminals. Two of those glasses were on the table, and if examined it would be seen that the positive discharge had apparently repelled the deposit as it formed from the negative wire, leaving a space somewhat analogous to the dark band which appeared in the luminous. Whatever might be the cause of the difference in the action of the electrical discharge between the positive and the negative, the disruption of the particles of metal in the latter was merely mechanical. The minute particles were disrupted by the force of the discharge, which, at the negative, met with resistance, and which resistance, under certain conditions, was attended with considerable heating effects, as if the wires were there, the negative invariably used, whether the discharges were made in air or vacuo.

THE EFFECT OF HIGH AND REDUCED PRESSURE UPON A GUTTA PERCHA COVERED WIRE.

The core subjected to pressure consisted of a copper wire diameter 2-32 of an inch covered with plain or ordinary gutta percha, 3-32 of an inch in thickness, 330 feet in length. The core was placed in an iron pipe filled with water, by means of an hydraulic pump, until the pressure reached three tons upon the square inch. The instrument employed for the measurement of the loss of insulation was a modification of a Peltier Electrometer, and for the measurement of the inductive discharge a very delicate Galvanometer. Battery power employed in each case 512 elements. Temperature of water in well of hydraulic pump, 54° Fah., half-past 9 A.M., July 30, 1860.

Inductive discharge on the core previously to its being subjected to pressure.

4
4·1
4·2 } 4·1 mean.

Loss of insulation previously to the application of pressure,
8 in. 15 seconds.

Inductive discharge on the core under a pressure of 5,277 lbs. on the square inch—

4·2°
4·2 } 4·2° mean.

Loss of insulation under same amount of pressure
8° in 45 seconds.

Pressure removed.

Inductive discharge { 4.1°
4·2 } 4·15° mean.

Pressure reduced to 3,958 lbs. by removing weights from scale.

Inductive discharge under the reduced pressure of 3,958 lbs. per square inch.

4·1°
4·1 } 4·1° mean.

Loss of insulation under reduced pressure
8° in 45 seconds.

Pressure further reduced to 2,969 lbs. per square inch.

Inductive discharge { 4·1°
4·1 } 4·1° mean.

Loss of insulation 8° in 40 seconds.

The temperature of the water in the pipe was 57°.

An accident prevented the further prosecution of the experiment. The loss of insulation, it will be observed, was slightly augmented under the lowest pressure, but the increased temperature of the water was sufficient to cause the increase of leakage. O. R.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	1s. 11d. to 2s. per lb.
Negro	1s. 1d. to 1s. 2d „
Java	1s. 5d. to 1s. 6d. „

Gutta Percha.

Fine	1s. 9d. to 1s. 10d. per lb.
Inferior	7d. to 8d. „

January 22, 1862. Wm. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do B. 7 per cent. till 1862	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
Stock	Electric Telegraph . .	100	95 to 98	——
20	Red Sea and India Telegraph	all	19 to 20	19
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	——
1	Do. registered . . .	all	3/8 to 5/8	——
10	Do. „ . . .	all	4 to 6	——
5	United Kingdom Telegraph .	2	1½ to 0½ dis.	——
	Mediterranean Extension Tel.	all	4 to 5	4½
	Telegraph to India . .	1	⅛d. to ¼ p.m.	——

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

THE BATTLE OF THE INSULATORS.

To the Editor of The Electrician.

Sir,—The vigorous and protracted "Battle of the Gauges" at one period arrested to some extent the development of the railway system. We have now to experience another stubborn contest between our insulating materials, which bids fair to outrival its predecessor of the "Gauges," and possibly to retard the progress of telegraphy. It appears, from several communications which have appeared in your journal, that we are as far as ever from arriving at the requisite amount of insulation for effecting telegraphic communication along submarine cables. The advocates of gutta percha may, however, congratulate themselves upon the prospect of a "sweet repose" from the excitement and vicissitudes of the battle-field, and become the exulting witnesses of the suicidal fray in the divided camp of their once redoubtable antagonist india rubber. Your correspondents "Insulator" and "Scrutator," evidently while deeply impressed with the superior excellence of their respective wares, unwittingly expose the vulnerability of the material to the attacks of the common enemy. I must confess that the prospect of india rubber appears to me a precarious one, if we are to form our judgment of its applicability for insulating purposes from the statements furnished by its own advocates.

22*nd January*, 1862. Investigator.

STANDARDS OF ELECTRICAL MEASUREMENT.

To the Editor of The Electrician.

Sir,—The purport of Mr. Latimer Clark's reply to my objection, so far as the interests of electricity require me to remark upon it, is that he justifies the standard of electrical measurement he publicly recommended, believing that although the *force* of electricity may vary as the squares of its quantities, still electrical *tension* may, and does, vary with the quantities in a simple ratio. This is physically impossible. Mr. Clark, I believe, distinguishes between *electrical tension and eletrical intensity;* but he will admit that, whether they be identical, or different, things, what I am going to say of them must be true; if they be not equivalent expressions for the electrical force itself they are effects of that force; and in either case they, as well as any reaction set up by them, must be treated as varying with it in one and the same ratio, whatever that may be. This is rigorously required by the principles of mechanical philosophy; and it is fatal to the distinction Mr. Clark is willing to allow; either electrical force, electrical tension, and electrical intensity all vary as the squares of the electrical quantities, or they vary with those quantities in some other ratio which is alike for all. But Mr. Clark doubts whether electrical force does actually vary as the squares of the quantities of electricity, and he explains away from his own mind the evidence of facts in this way:—"One measure of electricity upon an insulated con-

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ductor exerts a certain attraction upon a neighbouring body; if we add another measure upon a neighbouring body; if we add another measure the attraction is increased four times." "Two parts of this force are due to the increase of tension, which is doubled; and two to the increased number of particles in action (quantity of electricity) which is also doubled." This, to my mind, is not very lucid; two *when* added to two certainly make four; but does not Mr. Clark perceive that the doubled tension would, according to his view of simple proportion be the full effect of doubling the number of particles, so that his afterwards adding one doubling to another is vicious! It is to be regretted that he did not advance the reasoning another step, and calculate *three* measures of quantity, for his error would thus have been made obvious. We may now do it for him :—*one measure of electricity upon an insulated conductor exerts a certain attraction upon a neighbouring body; if we add a second and a third measures the attraction is increased nine times. Three parts of this force are due to the increase of tension, which is trebled; and three to the increased number of particles in action, which is also trebled.* But three added to three are only six, and not nine as required by the argument; which will not inadvertently slip, like the reasoner, from addition into multiplication; it so happens that $2\times2=2+2$, but with higher numbers it is not so, and if we adopt in their case the former mode of annotation we thereby admit the squares of the electrical quantities to be *purement et simplement*, as our neighbours would say, a law of electrical force.

I acquit Mr. Clark of singularity in putting forward this reasoning; for the quadrupled force of a doubled quantity of electricity has been accounted for in a similar manner by a scientific historian of eminence, apparently without his perceiving that the addition of any further quantity would give an erroneous result; and it may also be remarked, still in justification of Mr. Clark, that a well-known electrical writer, whom he occasionally quotes, makes electrical quantities and tensions to vary with one another in a simple ratio, though he asserts that electrical intensities vary as the squares of the quantities.

Of course it is quite competent for any philosopher to assign to particular words more definite meanings, if he can show good cause for doing so; but no such distinctions can make differences if they do not naturally exist; and my belief is that the expressions, force, tension, and intensity, as now generally used, mean precisely the self-same thing. I will illustrate this:—let us imagine we are dealing with pneumatic pressure, forcing air along small tubing of different long lengths; the initial pressure, to deliver the air at an uniform rate at the further end of all the tubes, must, according to a law well ascertained, vary as the squares of their lengths. Now, let those who prefer to use the word say that the *tension* of the compressed air in any one selected tube is not at all places equal; can they object if others express the same fact by saying that the pneumatic force is not equal, or not equally intense, at all places? So with electricity; we know it will infringe on the commencement of a long insulated conductor with an energy varying as the squares of the quantities of electricity, and we can conceive that energy to suffer diminution, as it passes along the conductor, which we may describe with equal propriety as a reduction in force, in intensity, or in tension. But the gentleman whose name I have mentioned so often intimates that on his return to Europe after a few months absence he may adduce experiments to demonstrate that "it is possible by inductive influence to cause the quantity (of electricty) to vary while the tension remains constant." As he has told us at the same time that the committee appointed to report to the British Association on the subject of electrical standards is not likely to recommend the one I have objected to as faulty, I can patiently await his arrival; but in the mean time I predict without any hesitation, that if by experiment he should appear to show that "the force does not vary as the square of the changeable function (quantity of electricity), but in the simple ratio, it will be because he (the electrician he quotes—sometimes setting him the example), has caused some part of it to be diverted in a way not taken into his calculation, and which probably I shall not find it impossible to indicate.

January 18th, 1862. AU REVOIR.

ELECTRICAL PERTURBATIONS IN TELEGRAPH WIRES.

To the Editor of THE ELECTRICIAN.

SIR,—Is there not an electrical error in the following passage in page 121 of your last number?—"But in very long overland wires, in which the static charge is small when compared with that of a submarine cable, the induction current or false discharge, as observed by Gavarret, overpowers the true discharge, &c., &c."

Should not "very long" read *very short*?

In his work on the telegraph (pp. 273, 274), referring to a wire with a Morse instrument at each end, Gavarret says that a rapid alteration in the strength of the current passing through the coils of the electromagnet at the receiving station, sets up in those coils an "*extra current direct*," that is, an induced current flowing in the same direction as the line current.

When the sending key falls back to the position for receiving (that is when it makes earth through the apparatus at the sending station) the line wire at the sending end is influenced by two currents flowing in opposite directions, viz., the "return current," and the "extra current direct" (as Gavarret calls it), which is set up by induction in the *coils* of the distant instrument.

On very long overground lines the resistance and length of the line wire are such that the current does not stop with sufficient abruptness in the receiving coils to produce more than a *feeble* "*extra current direct*," while, because of the length of the line, the *return current* is comparatively *powerful*.

On very short lines, on the contrary, the current passing through the receiving coils stops immediately battery contact is broken at the sending end, and in consequence, the "*extra current direct*" is strong, while the *return current* or discharge of the wire is feeble, because the line is short.

Thus, then Gavarret says, on a long line the return current overpowers the extra current direct, while the converse occurs on a short line, the extra current on it being stronger than the return current.

I have, I think, rendered his meaning faithfully. If I have said more than was absolutely necessary to point out what I thought was in error in p. 121, it was in order to make the subject (an important one in fast working) clear to our "Student" friend. AN OLD HAND.

[The words "as observed by Gavarrett" are liable to misconception; the extra current direct, referred to by him, being, as you have pointed out, the current induced in the coils of the electro-magnets. It would appear, however, that in addition to this effect of induction, the wire, in proportion to its length, exerts an inductive action upon itself; and that in very long circuits in which no electro-magnets are interposed a "false discharge" may be observed subsequently to the "true discharge." The case of a very long wire was cited, because in a short wire suspended in air the true discharge, and that portion of the false discharge due to the induction of the line wire upon itself, are practically inappreciable.—ED. E.]

TELEGRAPH FAILURES.

To the Editor of the ELECTRICIAN.

SIR,—I am quite willing to concede to your correspondent, "Electrician," the appropriateness of the title he has assigned to his communications, and should not have questioned it if his object had been more fully comprehensible in his first letter. I trust that all your correspondents will not only coincide, as he has done, in my general condemnation of illogical and unreasonable communications in your columns, but will practice what I preach, and, by the narration of carefully selected facts, the detail of well conducted experiments, and the expression of logically argued opinions, so further the progress of our science, that confidence may be restored, and unqualified success crown our future efforts in submarine telegraphy.

I cannot agree with your correspondent that the cables he named, not even the Atlantic, were ever subjected to such exposure of light and air, as to induce the exhaustion of the essential oil and moisture of the gutta percha; It must be recollected that they were all well protected with servings of hemp, well saturated with tar—a process that is known to preserve gutta percha, under most unfavourable circumstances for years. Had the plain gum been left to such exposure, then I will readily admit that their insulating powers would have suffered the serious deterioration described by Mr. Willoughby Smith. The Atlantic, the Mediterranean, and the Red Sea cables undoubtedly suffered from ill-treatment, but, as your corresondent justly observes, it was such treatment as no insulating material could have undergone without deterioration.

"Electrician" will excuse me if I continue to attach no credence to his bare assertion respecting the insulating capacity of the Malta and Alexandria cable. No cable that has ever been constructed, has been subjected to such careful tests as this cable. The core was tested under pressure by Reid's process. The cable itself was submerged (for the first time with deep sea cables). The Government placed the testing under the charge of Messrs. Siemens, than whom no one is more qualified to undertake such a duty. The contractors themselves had their own electricians for a similar purpose. Mr. C. Siemens, at the Institution of Civil Engineers, in the discussion upon Mr. Preece's paper, in the early part of last year, detailed these experiments, and produced facts which indisputably proved that the insulating powers of this cable far exceeded those of any other cable that had been constructed. Subsequent accounts from the Mediterranean have shown that the whole cable can be worked through with speed and certainty, with a marvellously low power—25 words per minute with 8 cells were the figures if I recollect rightly.

Compared with the carefully selected specimen coils supplied to the Government Experimental Enquiry, its insulation may have been *moderate*, but compared with all previously constructed cables, Mr. Siemens' figures showed it to be infinitely superior.

The defect of the stranded conductor, alluded to by your correspondent, is undoubtedly a serious one, but it must be recollected that it can only prove dangerous upon the occurrence of some injury to the insulating medium. As long as the gutta percha remains intact, no harm can ensue; but when once the water gains admission, the duration of the cable would be very problematical. It must however, be recollected, that the water can only extend from joint to joint, as the solder at those points completely fills the interstices of the wire, so that its progress would receive a speedy check. I do not know in how many pieces the core was supplied, but I should estimate that there are 10 or 12 joints in every mile. The projectors of this cable cannot well be blamed for the existence of this defect, because its occurrence was not known until ex-

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perienced by Mr. Preece in the Jersey cable, after the commencement of this undertaking, and it is one of those peculiar phenomena that could scarcely be foreseen. It is now carefully provided against.

While I join with "Electrician" in protesting against the treatment to which gutta percha has been hitherto subjected, I would ask, what more could we expect, when such undertakings are placed under the charge of such inexperienced hands as the gentlemen whose evidence "Electrician" has adduced in support of his argument?—inexperience detailed by their own words, and evidenced in their own descriptions—Mr. Forde, who did not feel himself capable of giving a decided opinion upon one of the simplest electrical problems, and Mr. Whitehouse who subjected the Atlantic cable, with open eyes and in broad daylight, to the "*rack of martyrdom*," as your correspondent terms the fearful punishment inflicted upon that unfortunate rope.

If I felt bound to express dissatisfaction at the manner in which "Electrician" handled his subject in his first communication, how much more cause have I to complain of your facetious friend "Momus!" He talks of a lamentable and unseemly strife among eminent and scientific men upon certain electrical and telegraphic points. I know of no electrical question that has ever been raised among eminent scientific men, that has not been discussed with gentlemanly courtesy and philosophic spirit. The only discussions that are preposterous, objectionable, and subjects for ridicule, are those raised by silly effusions emanating from some anonymous scribbler, who with an attempt at fun, a cry of monopoly, and a display of ignorance, would thrust india rubber down our throats, *nolens volens*, without that examination, without that consideration, and without that care and labour, which must ever distinguish any innovation in physical and practical science. As an humble labourer in the field of electrical science, and one who has no difficulty in grasping the substance of every theory that has been detailed in your columns, I trust "Momus" will excuse me if I state that I, at least, have no difficulty in arriving at one of his two following conclucions, viz.—either that he is "an unmitigated blockhead, or that the said theories are so dreadfully shadowy that the prolific parents of them cannot take in their outline." P. Q.

January 20th, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—I perceive that in my last I have committed an error in describing the probable cause of the effects in Professor Wheatstone's experiments, and I hasten therefore to correct it.

I state that if the end of the line were connected "to the same plate as the battery; then all the effects he (Professor Wheatstone) observed would be fully accounted for." I confess that in such case it seems to me impossible that polarization currents could be produced in the circuit.

I should have said "if the end of the line were connected to a *third* earth plate the effects observed might be due either to a galvanic action between the earth plate of the galvanometer and the earth plate of the line, or to polarization of the line plate occurring simultaneously with that of the battery plate.

In this case we have, on connecting line to galvanometer, a plate (the line plate) which has been acted on by the battery at one part of the circuit, and a plate (the galvanometer plate) which has not been so acted on in another part of the circuit, and we can, therefore, conceive that a current would be produced.

A combination of both these cases, viz., a galvanic action between the two plates, and the polarization of one of them would probably lead to the reversal of the current, for if the polarization were sufficiently powerful to overcome the galvanic action, and were opposed to the latter, it would at first predominate, but as polarization currents gradually decrease the galvanic action (which is more permanent) would at last predominate, and thus reverse the direction of the current. Some such effect appears to have taken place, for Professor Wheatstone describes the spontaneous alteration in the direction of the current. I may add that it was a rather hasty consideration of Professor Wheatstone's key which led me to the error I have alluded to.

In an ordinary key for testing return current, if the distant end of line be connected to one earth plate and the battery to another, the key is so arranged that it simply cuts out the battery and replaces it by the galvanometer; thus leaving the two earth plates in the circuit, and any current that is set up by the plates thus acts on the galvanometer.

F. C. WEBB.

Miscellanea.

ON the 6th of January last, between nine and ten o'clock in the evening, a telegraphic communication was despatched between Smyrna and Leipsic. In order to reach it destination the electrical current had to pass through Constantinople, Bucharest, Jassy, Czernowitz, Lemberg, Cracow, Oderberg, Prera, Olmutz, Pardubitz, Prague, Bodenbach, and Dresden, thus accomplishing a distance of about 2,000 miles. The message, which consisted of twenty-five words, was sent quickly, and without any delay, the whole time consumed in the operation amounting to four minutes only. Upon the departure of the despatch the time at Smyrna was one o'clock after midnight, and the message reached Liepsic at half-past nine on the evening of the previous day. The weather, also, at Smyrna was rainy, and at Liepsic fine but cold. At the same time a communication took place between London and Verona, a distance of more than 1,800 miles, the message going by way of the Hague, Amsterdam, Hanover, Berlin, Breslau, Oderberg, Prerau, Vienna, Gratz, Trieste, Udine, and Venice.

TELEGRAPH TO INDIA COMPANY.—The steamer with the new cable for the repair and restoration of the eastern division of the telegraphic cable between Aden and Kurrachee left London on the 1st January, and Mr. Latimer Clark, one of the engineers of the Telegraph to India Company, proceeded with the staff by the steamer of the 4th January.* It is stated that the attention of the engineers will be first directed to the land line belonging to the company between Alexandria, Cairo, and Suez, which will be at once made available, and a temporary station established about March next at the entrance of the Gulf of Suez, upon one of the islands of Shadwau or Jubal, at which telegraphic messages to and from India, China, and Australia will be received and despatched. This, a distance of 360 miles from Alexandria, shortening the time by about 36 to 40 hours, is an important step, as securing certain priority of information to those who avail themselves of it, as by the recent completion of the Malta-Alexandria cable the communication will be perfected between all parts of England and the Jubal station in the Red Sea. From the latter point the India, China, and Australia messages will be conveyed by the Peninsular and Oriental Company's steamers, under the sanction, already obtained, of her Majesty's Postmaster-General, until further advances shall have been made in the repairs or reconstruction of the cable. It is, therefore, recommended that merchants and others who require to make use of the line should give their instructions in anticipation, so that as soon as the notices of the completion of the Jubal station are issued, probably early in March, their correspondents may be aware of the advantages to be derived from it, and transmit their communications accordingly. It is further stated that the cost of a message between any part of England and any of the following places at which the Company have agents will not exceed £3 for a single message, viz., Aden, Bombay, Galle, Madras, Calcutta, Penang, Singapore, Hong Kong, Shanghai, King George's Sound, Melbourne, Sidney, Mauritius, and Reunion.—*Express.*

To Correspondents.

A SUBSCRIBER (Newport).—The following are the addresses of the head offices of the several telegraph companies in London:—Electric and International Telegraph Company, Telegraph-street, Moorgate-street, E.C.—The British and Irish Magnetic Telegraph Company, Threadneedle-street, E.C.—The Submarine Telegraph Company, Threadneedle-street, E.C.—The United Kingdom Telegraph Company, Gresham House, Old Broad-street, E.C.—The Telegraph to India Company, Moorgate-street, E.C.—The London District Telegraph Company, Cannon-street West, E.C.—The Universal Private Telegraph Company, 448, Strand, W.—Mediterranean Extension Telegraph Company, Gresham House, Old Broad-street, E.C.—Bonelli's Telegraph Company, Lincoln's-inn-fields, W.C.

P. L. (Liverpool).—The gentleman you refer to is not a "Fellow of the Royal Society." The question as to the relative position of "William Fothergill Cooke and Charles Wheatstone" with regard to the invention of the Electric Telegraph was subjected to arbitration. The arbitrators were the late Sir Isambard Brunel, Engineer of the Thames Tunnel, and Professor Daniell of King's College. The following is an extract from their award:—"Whilst Mr. Cooke is entitled to stand alone as the gentleman to whom this country is indebted for having practically introduced and carried out the electric telegraph as a useful undertaking promising to be a work of national importance; and Professor Wheatstone is acknowledged as the scientific man whose profound and successful researches have already prepared the public to receive it as a project capable of practical application; it is to the united labours of two gentlemen, so well qualified for mutual assistance, that we must attribute the rapid progress which this important invention has made during the five years since they have been associated.—Mc. I. BRUNEL, J. F. DANIELL, *London, 27th April*, 1841." "*London, 27th April*, 1841. Gentlemen,—We cordially acknowledge the correctness of the facts stated in the above document, and beg to express our grateful sense of the very friendly and gratifying manner in which you have recorded your opinion of our joint labours, and of the value of our invention.—We are, gentlemen, with feelings of the highest esteem, your obedient servants, WM. F. COOKE, C. WHEATSTONE. *Sir M. Isambard Brunel, and J. F. Daniell, Esq., Professor, &c., &c.*" It has long been a matter of surprise and regret that the Royal Society reckons amongst its members but a few practical telegraphists, and not one experienced in submarine telegraphy.

HISTORIAN.—We hope to be in possession of Dr. Hamel's interesting historical facts relative to the invention of the galvano-electric telegraph, for insertion in our next number.

F. G.—At page 113, 2nd column, 3rd line from the bottom, "insulated, or in free electrolytic contact with the earth," should obviously be "uninsulated," &c. Your suggestion may be of value.

MOMUS AND N. E. D.—Too late for this week.

* This is an error. Mr. Latimer Clark left London on the 9th inst., to proceed by the Overland Route *viâ* Marseilles to Alexandria.

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The Electrician.

VOL. I. No. 13.—JANUARY 31, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 134.]

13. THE first thing required is an electrical machine, by which to obtain the electricity to be submitted to observation and study; and we will bring to notice one of our own, not very difficult of construction, that possesses advantages we have never before seen combined. This will be at once understood by the experienced electrician, when we say that it affords in large quantities both positive and negative charges of high intensity even in damp weather, when electrical experiments are generally impracticable.

The base of the machine is a box 30 inches square, and 2 inches deep, with feet to raise it about 6 inches above the table on which it stands; its sides are of wood lined with very thin sheet lead turned back over the edges all round before the top and bottom are put on; these are of flat sheet iron, screwed against the lead all round, the bottom being thin, and the top only strong enough to give firmness to what it has to carry. Two of the angles of the base, diagonally opposite to each other, are occupied by vertical pillars that support a revolving cylinder; each pillar is of stout gas tubing, secured below by screw nuts, one on either side of the iron plate, and surmounted at the top by a T piece bushed with brass for receiving the pivots on which the cylinder turns. The cylinder is of crown glass, 29 inches long, and 12 inches diameter, made at the warehouse by cutting off the top of a tall glass shade; its cut edges are bound over with several thicknesses of cartridge paper, and over that is stretched an elastic band of vulcanized india rubber cloth, ¾ of an inch wide, and 3-16ths of an inch thick, its freshly cut ends being first cemented together by solution of caoutchouc in naphtha. The edges of the glass thus protected are received into grooves ¾ of an inch deep, turned in discs one inch thick of well-baked and varnished mahogany, the bottoms of the circular grooves being first floored with thick basil leather. From the centre of each disc projects a pivot, or trunnion, of hollow brass. These pass entirely through their respective T-pieces; one of them being left open at its termination, and fitted with a moveable stopper, the other being permanently closed and squared for receiving the winch or handle. The cylinder having been made perfectly clean, and also dry, is mounted in its place by first fitting on its ends, with their trunnions and T-pieces, and then dropping the latter both together on to the tops of the supporting pillars, the latter being for that purpose turned somewhat conical at their upper ends, and fitted to corresponding cones in the T-pieces, which are then secured to them by pins. The length of the bearings effectually secures the two discs from all motion but rotation, and thus provides against a tendency in the discs to become loose.

From the other two angles of the base arise vertical pillars of hollow glass, 1½ inches in external diameter, and ¼ of an inch thick. Such tubes may readily be procured at the glass-houses somewhat conical at one of their ends, so that a wooden socket with a conical aperture made to fit the outside of the tube, and with a broad foot all in one piece, slipped down to the end of each, will serve to receive screws passed upwards through the iron plate for securing the tubes in position just above holes in the plate one inch in diameter. The upper ends of the glass pillars enter tightly into deep holes made in two balls of pine wood, eight inches in diameter and covered with tin-foil. A stem of mahogany 1½ inches square sliding freely in a horizontal mortice from each of the balls towards the cylinder, carries at its end a cross piece ten inches in length. One of these cross pieces presents to the cylinder a row of five pointed wires, while the other fixed by its middle to the stem by a loose mortice and tenon joint with a pin through, is susceptible of a little horizontal movement. Both cross-pieces, as well as their stems, are covered with tin-foil, and the face of the swinging piece, which is 1½ inch deep is covered also with several thicknesses of woollen cloth, and finally with basil leather, to serve as a cushion; to the upper edge of which is sewn a flap of oiled silk ten inches wide, and long enough to reach over the cylinder to near the row of points on the other side. The face of the cushion is evenly spread over with a thin coating of amalgam, and made to bear gently against the cylinder by means of a spiral spring concealed in its ball and pressing against the end of its sliding stem. The axis of the cylinder is in the same plane as the centres of the balls carrying the cushion and the row of points; and these are raised twenty-two inches above the box on which they stand. Into this box are occasionally to be introduced, by a door in the cover, some shallow tin trays filled with chloride of calcium for dessicating the air within it, while a small pan of ignited charcoal, placed below its bottom, serves to heat the dried air and make it rise into all the four pillars of the machine, passing through the iron ones into their T-pieces and trunnions, and thence into the cylinder itself, the trunnions being for that purpose an inch in internal diameter, and, where they pass above the hollow pillars, perforated with large holes.

In consequence of this construction, and mode of using the machine, all its parts that need to be kept dry are maintained at *a temperature above that of the surrounding air*, so that, in obedience to a well-known law, moisture cannot become deposited upon them. To that consideration compactness has been sacrificed; where space is an object an ordinary cylindrical machine of much smaller size will often answer the student's purpose; its description, if required, will be found in most elementary works on electricity.

For the convenience of attaching other apparatus to the machine, each of its large balls is pierced with four deep holes, large enough to receive thick brass wires; one being in the centre at top, and the others in the sides at right angles to one another. The amalgam to be spread on the cushion may be made by melting together an ounce of tin and two ounces of zinc, then adding three-and-a-half ounces of mercury previously heated to about 300 degrees of Fahrenheit, and shaking the mixture until it becomes nearly cold, in a wooden box wrapped in a cloth to protect the hands while holding on the cover. The amalgam must afterward be very finely powdered in a mortar, sifted through muslin, and mixed with a little lard for use.

14. A machine being provided, the first use the student should make of it is to satisfy himself, by observing with his own senses, and bringing a little plain reasoning to bear upon his observations, that he may safely admit the assumption with which we are to start, namely, that electricity is a material thing, and not simply a force.

Exp. 1. Fill a clean and dry tube of glass, just large enough for the purpose, and a foot or two in length, with a row of common shot of the largest size; cap its ends with wood or brass, and insert through each cap a short brass wire bent into a hook at its outer end. Put the lower end of a tall metal rod into the top hole of each of the large balls of the machine, and by means of two short brass chains or wires suspend between their upper

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ends by its hooks the shotted glass tube. On turning the winch of the machine, electricity will be seen in the form of a series of bright sparks, in the minute spaces between the pieces of metal ranged in the line of communication.

15. In this experiment we see that electricity, whether it be matter with its own inherent force, or force separate from matter, is capable of becoming visible; and on that fact we found the following analogical argument:—particles of hygrometric water are invisible, and are made visible by coalescing into masses of magnitudes suited to our organs of sight. We may say the same of every other kind of thing that we know to be material. Therefore, if there be a material electricity, we should expect its particles to be invisible while dispersed in bodies, and to become visible if they coalesced into a sufficiently large mass. It is probable that what we call the electrical spark may be such a mass. On the other hand, if there were no electrical fluid, could electricity be ever, and not always, visible? if it be mere force it cannot have parts to coalesce for making it more visible at one time than another.

16. We have only two ways of making electricity visible, and they equally seem to teach that its visibility is due to the isolation and coalescence of its particles; one is by leaving it, when detached from solid bodies, nothing but the ordinary atmosphere or gases to combine with, and the other is by removing more or less of the air or gases from the course of its passage, by which we make it visible in diminished quantities. Of the first of these methods we have given an instance, and we will now add another.

Exp. 2. Fix one end of a long pointed wire vertically into that one of the balls of the machine which is not attached to the cushion; and, making the room dark, put the cylinder in motion. Electricity will appear against the point, presenting the appearance of a cone of diverging rays; now, this cone will enclose within it larger quantities of atmospheric air as the distances from the point become greater, so that at some distance the divergence of the rays must be conceived to have so extensively distributed the particles of electricity that they may no longer constitute a mass discernible by the sense of sight; and in conformity to this theoretical conclusion we find in practice that the cone soon becomes invisible.

17. The following is an example of the second method available for rendering electricity an object of sight.

Exp. 3. Place upon the plate of an air-pump a receiver 14 inches high and 7 inches diameter, with a pointed wire projecting an inch or two within it through its top; by means of metallic chains or wires connect the pump-plate with the ball that carries the cushion of the machine, and the other ball with the outer blunt end of the wire, whose point is within the receiver. Darken the apartment and commence to work, at the same time, both the machine and the pump; a brush of electricity will be seen against the pointed wire, gradually expanding itself as the vessel becomes emptied of air, until it visibly pervades its whole interior. Now, in this experiment the quantity of electricity passing through the receiver at all times was nearly the whole furnished by the machine; that quantity may therefore be regarded as sufficiently uniform, *and it was the more visible as it had less air to combine with.*

18. Mr. Morgan and M. Biot long ago attributed the visibility of electricity to light extricated from the air or gases by the mechanical pressure it occasions in them; the same explanation is still given by philosophers who deny the electrical materiality, and they base their conclusion upon the observed fact that electrical sparks are brighter as the gases in which they occur are denser. We shall, by and by, bring the student to understand that the brighter sparks contain larger quantities of isolated electricity assembled into a mass, on which account they ought to be more plainly visible.

19. The sense of touch also gives its evidence in favour of electricity being a material thing.

Exp. 4. Remove the apparatus from the balls of the machine; and, while the winch is being turned, present to one of them a knuckle of one hand, while a wire or chain from its fellow is being held by the other hand. Electricity will then be felt as well as seen. The simple inference from this fact is that a second sense contributes evidence of the materiality of electricity; *for we have no experience whatever of force coming into collision with our organs of feeling, unless it be accompanied by matter of some kind.* We can feel that matter gravitates, but we cannot feel gravity.

20. But we can adduce what we regard as absolute proof that electricity is material, by showing that it can be mechanically confined by common matter in places from which it strongly tends to escape, and which confinement would of course be impossible if it were only force. Indeed, under the circumstances alluded to, the force of the electricity passes, but itself remains behind. Gravity is a force of whose action we have definite and well founded ideas; we may therefore refer to it for an illustration of what we mean respecting the electrical force. Now, gravity can act between two given points, notwithstanding that any or all kinds of matter be interposed, and so can the electrical force; but no matter can pass with the gravitation from one of the points to the other, through all substances that may be made to intervene, and neither, under the same circumstances, can electricity pass with the force it sends through. We know that if the tube used in *exp.* 1 could be sealed up by a sudden fusion together of the sides of the glass at any point of its length, the passing electricity would be there arrested, though the electrical force would pass the obstruction. It may be useful to show this, and we can in effect do so by modifying the experiment.

Exp. 5. Make two small squares of flat window glass clean and dry; spot one of them at several distant places with drops of melted sealing wax; and having laid it upon two sticks of the same material, with the spotted surface uppermost, and with its under surface over and near to some fragments of paper, place upon the spots the second glass, then put upon the latter some extra electrity by rubbing it with a warm pad of dry silk. The electrical force will pass through to the under side of the lower piece of glass, and there produce the effect of attracting the fragments of paper: but the electricity will remain on the upper glass, as may be thus proved: separate the two glasses, and present one after the other to the fragments of paper; the only one that will now be found capable of attracting them will be that upon which the electricity was placed, and upon which it is thus proved to be still remaining.

21. Observation, therefore, warrants us in regarding electricity as a material thing; but still holding the conclusion in abeyance until it become irresistibly confirmed by its entire conformity to the results of our future experience, we may next try to learn *the direction* of electricity when it passes from one body to another; for it is only by learning that we can know which of any two objects it makes *plus* and which it leaves *minus*, and this knowledge in a theoretical point of view is very important.

22. Until next week let the student ponder over these small beginnings; let the adept, instead of indulging perhaps a first feeling of disdain for indignity offered to his superior power of progressing, set about (it may in some cases be for the first time) analyzing the indications of our old and simple experiments, even though it be with a view of gainsaying our inferences. He may, perhaps, reap a reward from even so seemingly unpromising an investigation, as, upon like occasions, other philosophers have done before him. "I had often smiled in the pride of half-knowledge," said the candid Dr. Wells in his very scientific essay on dew, "at the means employed by gardeners to protect tender plants from cold; but *when I had learned* that bodies on the surface of the earth became colder than the atmosphere, I perceived a just reason for the practice." Are there not also learned electricians who might take a few steps backwards with advantage!

(To be continued.)

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TELEGRAPHIC DELAYS.

IT is gratifying to be able to state that the delays in the transmission of telegraphic dispatches, to which we referred last week, have not been occasioned by any neglect on the part of English officials. In the case of the messages forwarded from Liverpool for transmission to the Portuguese capital, the necessary degree of promptitude is shown to have been observed as far as the Spanish frontier. Beyond this our enquiries cannot reach; but we are informed that on the representations of the Submarine and European Telegraph Company, measures will be taken by the French authorities to ensure the immediate transmission of dispatches which reach the Peninsula *viâ* France.

With regard to messages to Alexandria, and also for Malta, in which delay has occurred, the fault is in most cases clearly traced to the Italian lines. In these a considerable improvement has lately been evidenced, which is fully accounted for by the following note of the Italian Minister for Public Works, relating to the telegraphic service :—

DIRECTION GENERAL OF TELEGRAPHS.—SUPERINTENDENCE.—PROGRESS OF THE LINE.—INSPECTION.

For about a month the telegraphic service in the Tuscan, Neapolitan, and Sicilian Divisions, has been subject to frequent interruptions on the wires, and delays in forwarding despatches: and the rules prescribed by the Regulation, for the prompt communication of despatches for the Government, as well as for individuals, have not been generally observed at the offices of the stations. There are also complaints of the little attention, on the part of the officers, in replying to the remonstrances of the Director-General, respecting the irregularities and neglect which are denounced.

Such a state of things not being tolerable in any service, and still less in this, which is of so much importance, the undersigned, with the consent of the Minister for Public Works, has ordered an inquiry on all the lines in Tuscany, Naples, and Sicily, for ascertaining the causes of the above mentioned disorder, and for applying thereto a prompt and efficacious remedy.

The Inspectors D'Amico and Salvatori, and the Sub-inspector Penzio Vaglia, are in consequence commissioned to travel over the abovementioned lines, to inspect the offices and determine the causes of the aforesaid interruptions and delays, with power also to remove those persons employed whom they may consider it necessary, and suspend from the service those who may be found culpable of a non-observance of its rules—the Government being desirous that those may be removed who are not fit for the service, or who may have manifested a culpable negligence in the same.

The Delegates will draw up verbal process of the condition of the lines, of the offices, and also of the investigation which they will make respecting the persons employed. They will also adopt such measures as they may consider useful, either for repairs of the line or for the reorganization of the offices; and they will make a report upon the whole for further dispositions.

BONA,
Director-General.

Office of the Minister for Public Works,
December 22, 1861.

THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.

THE rise and progress of the first telegraph Company must ever be regarded as one of the most important episodes in the history of our material progress. It is not our present purpose to trace its origin, or to follow this great enterprise from the small office in Copthall Buildings, once occupied by William Fothergill Cooke, to the more spacious premises in the Strand; thence to Lothbury and throughout England. We may simply record the fact that the Electric and International Telegraph Company was founded by the joint efforts of Mr. Cooke, John Lewis Ricardo, M.P., and Richard Till. To these gentlemen, their present coadjutors, and their engineer and electrician, Mr. C. F. Varley, we are indebted for the opportunity of examining the very perfect and extensive arrangements of the Company; some of which, as already notified, we will endeavour to bring before our readers.

The Battery Cellars at the Central Station.—Passing out of Moorgate Street into Telegraph Street, the most conspicuous building is that which constitutes the head quarters of the Electric and International Telegraph Company. From the entrance hall we pass through a glass door and down a flight of stone steps, leading to the engine room and battery cellars. The engine is for the purpose of working the pneumatic arrangements for the conveyance of written messages, &c., between this station and those at Lothbury, the Stock Exchange, Cornhill, Old Broad Street, and Mincing Lane. The battery cellars constitute, however, the object of our present visit; and the methods which are here adopted for generating and distributing the enormous electric power required for the purposes of the Company were kindly explained to us by Mr. W. H. Winter, the assistant engineer.

Arranged side by side upon shelves, like the coffins in some ancient catacomb, are a multitude of wooden boxes, from which proceeds the life of the electric wire—through which intelligence and thought may vibrate through any distance, and may be made active almost at the same moment of time, at points which are separated by the vast expanse and depth of the ocean. These boxes we are told, amount in number to 720, each containing some 10 and some 12 battery cells. The battery power is subdivided into batteries for continental lines, for shorter wires, and local batteries for working the instrument at the station. The following cut represents the modification of the Daniell's battery, arranged we believe by Mr. John Muirhead, one of the company's officers, which is generally employed for the two former purposes.

FIG. 1.

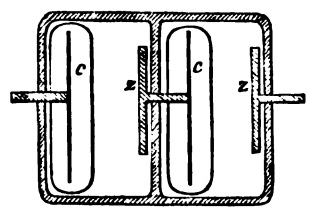
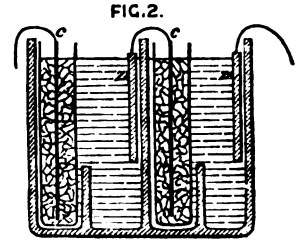


FIG. 2.



The outward vessel is formed of porcelain, and consists of two battery cells. The copper element C is immersed in a porous vessel containing crystals of sulphate of copper. In order to avoid as much as possible the gradual exosmosis of the copper solution, and its consequent action upon the zinc element Z, the porous vessel is saturated with tallow, excepting upon a portion of the surface, which is directly opposite to the zinc plate. This improvement of Mr. C. F. Varley's effects an enormous economy —over 40 per cent., in the battery consumption. Instead of the porcelain vessel, battery cells constructed of ebonite are employed with advantage.

The batteries used for local purposes have the zinc and copper elements somewhat larger in size, and disposed horizontally, the copper element being beneath. Crystals of sulphate of copper are placed on the copper plate, which is long enough to be folded back over them. The cells are then filled with dilute sulphuric acid, 1 to 60, no porous cell being used; these are Varley's patent gravity batteries, and give very large quantity combined with constancy.

The arrangements for distributing the battery power are as follows :—Fixed upon the wall down stairs are several large slabs of dried mahogany, with a number of brass binding screws disposed in groups of four. To the lower two screws of each group, are connected the wires from a set of batteries. These screws are connected by two pieces of wire to the upper terminals of the group, which lead up to a box in the instrument room, similar in every respect to the one down stairs. These two lower terminals in the upper box are again connected to the upper pair of terminals (in the group of four), and from these wires are led to their respective instruments. By similar means, but in another box, the land-wires, and wires from the earth, are also connected to the respective instruments.

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When any change is made in the office as regards the instruments or the batteries, the wires between the upper and lower boxes are not disturbed.

The local batteries are led in a similar way to their respective instruments, to be brought into play by means of a relay; the latter being worked by the currents coming from the distant stations. In this way the very feeble current from the long line is made to put into play a battery of very considerable power. A current that will produce a magnetic force capable of lifting but a few grains is sufficient, in consequence of its relay, to work the heavy apparatus of a printing telegraph. No less than 800 wires communicate with the instrument room from the battery cellar. One "earth-wire," consisting of stout copper wires twisted into a strand, is used for all the battery arrangements. The "earth-plate" attached to the end of this wire consists of a large plate of copper connected with the gas and water piping, in order to obtain the greatest amount of surface practicable.

(To be continued.)

DR. HAMEL'S ACCOUNT OF THE RESULTS OF HIS INVESTIGATIONS RELATIVE TO BARON SCHILLING AND HIS CONNECTION WITH SOEMMERRING'S TELEGRAPH.

HAVING expressed to Dr. Hamel a wish that he should favour us with some particulars relating to Baron Schilling, stating, in the first instance, when and how his attention was directed, at Munich, to Soemmerring's galvanic telegraph, he has obligingly furnished us with the following account, containing the results of his laborious and persevering researches:

Although the art of telegraphing by means of electricity is the most interesting application of scientific discoveries to purposes useful to Society at large, and although that art is already spread over a great portion of the globe, nobody has studied and described its first development.

I have therefore undertaken the task, sparing neither pains nor time, to discover its true history. Already I have communicated an account of the origin of the first galvanic telegraph, and now I shall show how it attracted the attention of the person who subsequently became the mediator of the introduction of the electro-magnetic telegraph.

The father of this individual was Ludwig Joseph Ferdinand Schilling, descended from the Talheim line of the old family of Schilling of Canstadt in the kingdom of Würtemberg. Having entered the Russian service, he was attached to the Marine Cadet Corps at St. Petersburgh.

On the 27th June, 1785, he, having at that time the rank of lieutenant, was married at the principal church (Domkirche) at Reval to Catherina Charlotta von Schilling, daughter to the late Major-General von Schilling.

The first child of this marriage, a son—the subject of the following account—was born at Reval on the 4th April, 1786, and was baptized in the before-mentioned church on the 19th of the same month. His godfather was nobody less than the grandfather of the present Emperor of Russia, the Grand Duke, afterwards Emperor, Paul Petrowitch. The child was, therefore, named Paul. In the absence of His Imperial Highness, his Excellency the 'Ober-Commandant' of Reval, von Essen, officiated.*

These particulars I have but lately (in September, 1860,) learned from an examination, made by me at Reval, of the Register kept at the said principal church.†—Before I discovered the real birthplace of Paul Schilling, it was supposed that he had been born at Kasan, and this was even written under the large portait of him hung up in the chief telegraph-office at St. Petersburgh.

The father, who died on the 3rd February, 1797, at Kasan, held at the time of his decease the rank of colonel. He was decorated with the military Order of St. George, and was the chief of the musketeer regiment of Nisow.‡

His widow married Baron Karl von Bühler, who was born, in 1749, at Stuttgart, and who had entered the Russian service in 1774.

Paul Schilling was already, at the age of nine years (1795), made ensign in the regiment of his father, after whose death he was, on the 7th March, 1797, received into the first Cadet Corps at St. Petersburgh, and when sixteen years old, he, on the 18th September, 1802, became second-lieutenant in the 'General Stab.'

As his step-father, Baron von Bühler, had been appointed Russian Minister at Munich, and his mother resided there also, young Paul Schilling, was, in May, 1803, attached to the College of Foreign Affairs at St. Petersburgh, and at once transferred to the Russian Mission at Munich.

I have mentioned in my former note, that Soemmerring, in 1805, had become a member of the Academy of Sciences at Munich, having just then been on the point of accepting an invitation from the Imperial Academy of Sciences at St. Petersburgh.

From his diary and correspondence I have learnt that for several years, even to the time of his inventing the telegraph, he felt an inclination to go to Russia.

In 1805 he wrote: "Jedermann räth mir zu. Kalt ist's freilich dort (in Russland), aber die unabhängige Lage!" (1.) In July of the said year, when he had already gone to Munich, he wrote to his friend Heyne at Göttingen: "Mein unruhiger Geist will mich immer nach Petersburg ziehen. Es ist und bleibt, ausser London, doch der erste Platz für mich." (2.) Heyne wrote him on the 1st August: "Ich will gern noch überleben, dass sich eine Brücke nach Petersburg findet." (3.) On the 13th October, 1808, Soemmerring noted: "Jeh bin schr unschlüssig wegen Russland," (4.) and three days after: "Nicht klar über Russland. Allein spazirt, um die Sache durchzudenken. Zu keinem rechten Resultat gekommen." (5.) On the 2d November: "Mit Harnier (his friend, the Hesse-Darmstadt Minister) spazirt. Mit ihm überlegt wegen St. Petersburg." (6.) On the 19th November he noted: "Es wird mir ein Project klar, nach Russland und von da, nach erworbenem Capital, nach England zu gehen." (7.) Even on the 17th October, 1809, after he had already made the telegraph, he noted again in his diary: 'Lust nach Russland.' (8.)

I quote these remarks of Soemmerring, because they seem to show that he was prepared to receive somebody from Russia in a friendly way, and to make him acquainted with his telegraph, invented in July and August, 1809.

This invention of Soemmerring constitutes the transition from the optical telegraph to the galvanic or electro-voltaic.

There was at Munich a club, called the Museum, at which the members used occasionally to dine.

On the 11th August, 1810, it so happened that Soemmerring and Schilling sat during dinner next to each other. I must suppose that their conversation turned on the telegraph, and that Schilling was invited by Soemmerring to come to him to see it, for I found mentioned in the diary of the latter, that two days after the said dinner, on the 13th August, Schilling paid him a visit and saw the telegraph in action.

From this visit dates Schilling's attachment to telegraphy. He appears to have been forcibly struck with the probability of future great usefulness in the application of electricity to that art, and he himself became subsequently the medium of the introduction of the electro-magnetic telegraph. His enthusiasm caused him to induce other persons to see Soemmerring's invention. He, of course, conversed a great deal about it at the Russian embassy, to which, as we know, he was attached.

After Baron Bühler, Prince Iwan Iwanowitch Bariatinsky had become Russian Minister at Munich. The Prince not only visited Soemmerring on the 12th April, 1811, to get a correct knowledge of the telegraph, but afterwards repeatedly invited him to his house.

* There were present at the ceremony: the Governor of Reval: Grotenhielm, the Marshal of the district: Tiesenhausen, the Counsellor of Court: Hoffmann, Major von Brevern; also the wives of General Gersdorf, of General Toll, of the Counsellor of State Brevern, of Judge Fersen; Miss Bagghuffwudt, and others.

† In this church there are monuments to the memory of Admiral Samuel Greig (native of Scotland), and of Admiral Krusenstern, the circumnavigator of the globe.

‡ Paul Schilling had a younger brother, Alexander, and two sisters, Johanna Wilhelmina Dorothea, and Theresia Wilhelmina Louisa. The former of the two sisters had been married to the late Count Banfy, and lives as widow at Vienna. The other was married to Professor Hruby at St. Petersburgh. This sister, as well as the brother, are deceased A sister of the father had, in 1780, been married to General Christoph von Benkendorf. She was attached to the service at the Court of the Empress Maria Fedorowna. Of the four children resulting from this marriage, Alexander (born 1783), subsequently created Count, and Daria, afterwards Countess, and latterly Princess Lieven, have become the most known. The patronage of Count Alexander Benkendorf, who occupied very high posts in the Imperial service, was useful to Paul Schilling.

(1.) Everybody advises me to go (to Russia). True, it is cold there; but the independent position!

(2.) My restless spirit constantly endeavours to draw me to Petersburgh. It is and remains, with the exception of London, the first place for me.

(3.) I shall be glad to live to see a bridge found for you to go to Petersburgh.

(4.) I am very undecided about Russia.

(5.) I do not see clear with regard to Russia. I took a walk alone to consider the matter, but did not arrive at any satisfactory conclusion.

(6.) I took a walk with Harnier (his friend, the Hesse-Darmstadt Minister). Consulted him about Petersburgh.

(7.) A good project would be to go to Russia, and, having acquired capital, remove to England.

(8.) Desire to go to Russia.

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There, on the occasion of a dinner on the 6th August (1811), he presented Soemmerring to Prince Leopold of Saxe Coburg, the present King of the Belgians, who, on the 22nd of the said month, honoured Soemmerring with a visit to see the telegraph. Prince Bariatinsky also conducted other persons to Soemmerring, for instance, on the 16th August (1811), the architect Quarenghi,* and on the 21st April, 1812, Count Andrei Kirilowitch Rasoumoffsky.

Prince Iwan Iwanowitch Bariatinsky was the father of the present Governor-General of the very extensive Caucasian district, Prince Alexander Iwanowitch Bariatinsky, Chief Commander of the Caucasian army, and Commander of the Caspian flotilla, General field-marshal and General aide-de-camp, who has a summer residence at Borshom, which place has lately been telegraphically connected with the line extending from Tiflis by Gori and Suram to Poti, on the most Eastern part of the shore of the Black Sea.

It was Baron Schilling, who, on the 7th May, 1811, had introduced to Soemmerring the lieutenant-colonel in the Bavarian artillery, Baron Comeau, who subsequently made the campaign to Russia, and to whom I owe a confirmation of the success of experiments, made by Schilling in the autumn of 1812 at St. Petersburgh, to explode powder mines across the river Newa. Baron Comeau afterwards, on the 9th October, 1811, invited the Bavarian Minister at Paris, Anton de Cetto, to visit Soemmerring, which he did, accompanied by his son, the present Bavarian Minister in London, Baron August de Cetto.

On the 14th May (1811) Baron Schilling conducted the Russian Count Jaroslaw Pototzki—then colonel attached to a corps of engineers—to Soemmerring, from whom the Count obtained a telegraph apparatus, with which he operated, on the 9th of June, before the Imperial Austrian family at Baden, near Vienna.

It was in consequence of Baron Schilling's proposal, that in June (1811), experiments were made near Munich on the river Isar, to telegraph through water. Count Pototzki, and the well-known Bavarian engineers, Baader and Wiebeking, were present at these experiments, which were similar to those made in 1803 by Galvani's nephew, Giovanni Aldini, near Calais in the sea, and near Charenton on the river Marne. Baader had seen the telegraph in Soemmerring's dwelling on the 26th of May.

In the months of June, July, and August (1811) the aeronaut, generally called Robertson, although his real name was Robert, frequently visited Soemmerring. He offered to make the telegraph known in Paris.†

On the 22nd January, 1812, Baron Schilling came to Soemmerring with George Reichenbach, who (like Fraunhofer and Utzschneider, also Liebherr and Ertel,) is so well known as having furnished many excellent astronomical and mathematical instruments, of which Russia has some at the observatories at Dorpat and at Pulkowa.—Reichenbach took a great interest in the telegraph.

I found that Schilling in 1812, when Russia was threatened with war by France, had at Munich been zealously endeavouring to invent an electrical conductor and an apparatus, with which he might ignite gunpowder at a distance, not only through moist earth, but even through water.

On the 8th April (1812) Soemmerring noted in his diary: "Schilling arrives, almost out of breath, with his idea about blowing up mines. Take care! take care!"

On the following day, Schilling came not less than four times to Soemmerring, and, on the 13th May, the latter wrote in his journal: "Schilling is quite childish about his electro-conducting cord and apparatus for igniting gunpowder."

On the 20th July (1812) Schilling had to separate himself from his friend Soemmerring and from his telegraph. Owing to the state of politics at that time, the Russian mission at Munich was suspended.

Soemmerring noted in his diary his sincere regret at the separation from his friend. He wrote: "Abends kommt der gute Baron Schilling um von uns Abschied zu nehmen. Er iat, so wie wir, sehr gerührt. Es ist ein Jammer, dass er auf solche Weise von uns scheiden muss. Mit ihm geht uns mannichfaltige Unterhaltung verloren."‡

To give an idea of the great attachment which existed between Schilling and Soemmerring, I may here mention, that in the first half of the year 1812, notwithstanding Schilling's having made two excursions, one to Stuttgart and the other to Vienna, they were together one hundred and five times.

In 1813, Schilling, like so many of his countrymen, joined the army. He became 'Staabsrittmeister,' in a regiment of hussars (it was that of Ssum.)

In the following year he was in the actions: near Bar-sur-Aube on the 27th February, near Arcis-sur-Aube on the 20th and 21st, near Fere Champenoise on the 25th, and close to Paris on the 30th March. On the following day, the 31st March, he was at the ever-memorable entry of the allied troops into Paris, having His Majesty the Emperor Alexander I. at their head.

Schilling has told me that during his stay at Paris, he, to the astonishment of many persons, ignited gunpowder across the river Seine by means of his conducting cord and igniting apparatus.

Soemmerring once wrote to Schilling, that his, Schilling's "igniting at a distance" (Fernzünden) had been more difficult to invent than his, Soemmerring's "signalizing at a distance" (Fernzeichengeben).

On the 17th July, 1815, Schilling—who had in October, 1814, become again attached to the College of Foreign Affairs—came quite unexpectedly to Soemmerring.

He was now zealously occupied in acquiring a thorough knowledge of the art of lithography, highly inproved by Aloys Sennefelder at Munich, in order to be able to establish it in Russia—a task which, after long protracted exertion, he was completely successful in accomplishing.

Soemmerring assisted him in various ways; he even accompanied him to Solenhofen, near Reichstatt, where Schilling concluded a bargain about lithographic stones for Russia. Soemmerring profited by this excursion to enrich his collection of fossils.

His "Ornithocephalus longirostris" was preserved as one of the most remarkable objects in the Museum of Natural History at Munich, where afterwards, in 1828, Agassiz, when following a course of medicine, had his attention first called to the study of fossil fishes. A cast in plaster of Paris of this Ornithocephalus; and casts from other organic fossils, which Soemmerring had shown me in 1819 at Frankfort, I have now seen here in London at the British Museum.

Schilling had only been four days in Munich, when he proposed to Count Fedor Petrowitch van der Pahlen, who had been not long before appointed Russian Minister there, to call on Soemmerring in order to see his telegraph.

Count Pahlen often repeated his friendly visits, and sometimes conducted, as Prince Bariatinsky had formerly done, other persons to Soemmerring, that they might get an idea of the telegraph. Among them were the Princess of Hohenlohe and Madame Lerchenfeld.

On the 29th December (1815) the well-known Johann Salomon Christian Schweigger, Professor of Natural Philosophy and Chemistry at the "Real-Institut" at Nürnberg, came to Soemmerring, when Schilling was with him. He was on his way to Paris and London, in which latter capital I had afterwards the pleasure of making his acquaintance.

Schilling at that time of course did not foresee that a subsequent invention of Schweigger's (the multiplier) would enable him to make at St. Petersburgh the first electro-magnetic telegraph.

Schweigger had in 1811 and 1812 in the "Journal für Chemie and Physik," which he then edited, made mention of Soemmerring's telegraph, which he knew only from the "Denkschriften" of the Munich Royal Academy of Sciences, and had proposed the firing of a voltaic gas pistol as a means of attracting the attention at a distance to the signals which were to be sent.—He did not know that Soemmerring himself had then already invented an alarum, which was not mentioned in the "Denkschriften."

The Abbé Moigno in his "Traité de Télégraphie Electrique," edition of 1852, page 64, states that Schweigger had made his proposal (27 years later, in 1838!) in the "Polytechnisches Centralblatt," which, Moigno believed, Schweigger edited. This Journal was edited by Julius Ambrosius Hülse at Leipzig. It contains nothing about Schweigger's proposal of an alarum.

Whilst Schweigger remained at Munich, he was almost constantly with Schilling and Soemmerring. They made various experiments, particularly with Zamboni's so called dry pile, from which at that time great things were by some persons expected. They dined together at the Museum, where Schilling, in 1810, was, during dinner, invited by Soemmerring to come to him and see the telegraph.

It was Baron Schilling, who on the 2nd July 1816 introduced to Soemmerring the English Minister, the Honourable Frederick James Lamb, afterwards Lord Melbourne, brother to Lady Palmerston, and who was the first Englishman that ever saw a galvanic telegraph.

* Quarenghi constructed, at and near St. Petersburgh, several buildings, as for instance: the *Manège* of the Imperial Horse Guards at St. Petersburgh, the Alexander Palais at Zarskoe Selo, the Villa Alexandrina, near Peterhof.

† With this Robert, the Russian Academician Lowitz, was, in 1804, to have made at St. Petersburgh a balloon ascent for scientific purposes. In the place of Lowitz, who became unwell, the Academician Sacharow made the ascent. In the "Encyclopœdia Britannica," (eighth edition,) it has been erroneously stated, that Biot's and Gay Lussac's balloon ascents "are memorable for being the first ever undertaken solely for objects of science."—The ascent in Russia, caused by the Imperial Academy of Sciences, took place in the month of July, but Biot's and Gay Lussac's on the 24th August. Gay Lussac alone made his ascent on the 10th September of the same year.

‡ In the evening comes the good Baron Schilling to take leave of us. He is, like ourselves, much affected. It is a pity that he is obliged to leave us. With him we lose manifold agreable intercourse.

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Schilling had at the same time taken his own sister, the Countess Banfy, and her husband, to see it. They were on a visit to Munich from Vienna.

As I have not named all the persons known to me as having visited Soemmerring to see the telegraph, I will mention some of them here.

Already in August 1809, Soemmerring had shown it to Baron von Moll, the Secretary of the physico-mathematical Class of the Academy, to the Academician Gehlen, well known as a chemist, and to his particular friend, the Hesse-Darmstadt Minister, Harnier.

On the 6th April, 1811, the Austrian Minister; Baron Wessenberg, the Westphalian: Baron von Scheele and the Minister from the Grand Duchy of Baden: Count von Seyboltsdorf, had been to see the telegraph along with the Bavarian General of Infantry, Erasmus Deroy, who, making afterwards the campaign to Russia, was mortally wounded in an engagement with Witgenstein's troops, and was buried near Polotzk.*

The Minister Count Montgelas with his lady, sister to Count Arco, visited Soemmerring on the 22d May, 1811.

The Saxon Minister, Count Einsiedel, had accompanied Prince Leopold, the present King of the Belgians, to Soemmerring, on the 22d of August.

The High Chamberlain, Count Rechberg und Rothen Löwen, had come to see the telegraph on the 1st February, 1812, with His Highness Karl Theodor, the second son of the King of Bavaria, who was also accompanied by the Academician and Professor of Natural Philosophy, Maximus Imhof.

Dr. Assalini, physician to the Vice-Roi of Italy, Prince Eugene Beauharnois, afterwards Duke of Leuchtenberg, visited Soemmerring for the first time on the 26th July, 1814.

On the 2d October, 1814, Christoph Heinrich Pfaff, Professor at Kiel, came to Soemmerring to examine the telegraph. He had early paid attention to Galvani's discovery. Already in 1793 and 1795 he had printed treatises on "Animal Electricity and Excitability," and subsequently he wrote (1824) on "Electro-Magnetism;" in 1837: "A Revision of the Doctrine of Galvano-Voltaism," and, in 1844: "On the Parallel of the Chemical Theory and Voltaic-contact Theory." Besides these he published a great many other papers on a variety of subjects.

On the 27th May, 1820, Maria Leopoldina, daughter of the late Archduke Ferdinand of Austria, and, since 1799, widow of the Elector of Pfalz-Bavaria Karl Theodor, came to Soemmerring, accompanied by several foreign Ministers, among whom was the French Count de Lagarde, who had been in the Russian service, and who expressed a wish to get a telegraph apparatus for Paris.

In April 1818 Baron Schilling had announced to Soemmerring, that the Emperor Alexander I. had created him Knight of the Order of St. Anne of the second Class. He was in the same year made a member of the Mineralogical Society at St. Petersburg, and in the following year (1819) the Imperial Academy of Sciences elected him an honorary member. Already in 1810 Soemmerring had received from the Emperor Alexander I. a diamond ring for his work on the "Sinnesorgane," which Count Nicolay Petrowitch Rumianzoff had presented to the Emperor.

On the 12th October, 1820, Soemmerring left Munich—where he had never felt himself quite happy—for his favourite city, Frankfort, where he spent the remainder of his life.

On the 7th April, 1828, he celebrated there his "fifty years Doctor's Jubilee," to which a great many men of science from various places had come.

On the 24th November, 1823, Soemmerring had been in Frankfort unexpectedly gratified by Baron Scilling's arrival, but he only stopped till the 5th December, having, however, been every day with Soemmerring.

A correspondence was kept up by the two friends, as a specimen of which I give here the commencement of a letter which Soemmerring wrote to Schilling in the last year of his life, on the 8th May, 1829.

"Mein unvergesslicher Freund! Ich kann die herrliche Gelegenheit die sich mir darbietet, nicht unbenutzt vorüber gehen lassen, um mein Andenken bei Ihnen zu erneuern und zu erforschen, ob ich denn nicht so glücklich sein soll, vor meinem seligen Ende noch einmal die Handschrift meines lieben Baron Schilling's zu erblicken und von ihm selbst zu vernehmen, dass er mich und die Meinigen nicht gänzlich vergessen hat u. s. w. Ihr ewig treu ergebener Soemmerring." †

The inventor of the first galvanic telegraph, the inciter of a desire in Baron Schilling to be active in the field of telegraphy, the excellent man and philosopher, Privy Counsellor Soemmerring (born on the 28th January, 1755, in Prussia, at Thorn, the birthplace of Copernicus) died at Frankfort on the 2nd March, 1820.*

When one studies the life and the labours of Samuel Thomas Soemmerring, it is impossible not to feel a high esteem for him. Not vanity, not eagerness for gain, but pure love of science, and the wish to be useful, were the motives of his incessant activity.

Much has been published about his anatomical and various other scientific labours—even his observing during the last years of his life the dark spots on the sun has been noticed—whilst his doings with regard to the telegraph have remained undescribed.

Although his telegraph could never have served for any considerable distance, still it must be had in view, because it laid the foundation of that so eminently useful art, which his pupil, Baron Schilling, became the mediator to introduce.

In the printed account of the public meeting of the Royal Bavarain Academy of Sciences, which took place on the 29th March, 1859, to celebrate its Jubilee, I was not a little astonished to find that in the oration made to recall to memory the merits and labours of defunct members of the Academy, nothing more was said of Soemmerring than: "He was one of the first who contrived a galvanic telegraph (Soemmerring war einer der Ersten, die einen galvanischen Telegraphen erdachten)."—These are very few words, and even they are not correct. Soemmerring's telegraph was not "one of the first," but the very first galvanic telegraph.

I reserve the description of Baron Schilling's subsequent very important labours in telegraphy for another occasion.

J. HAMEL.

SIR CHARLES BRIGHT ON THE STATE AND PROGRESS OF TELEGRAPH OPERATIONS.

ON Saturday, at Liverpool, Sir Charles Bright was presented with a testimonial, on his relinquishing his position of engineer-in-chief of the British and Irish Magnetic Telegraph Company, of which in future he is to be the consulting engineer. The presentation took place at the George Hotel, Liverpool, and consisted of a handsome silver candelabrum, valued at 140 guineas, which had been subscribed for by some of the friends and colleagues of Sir Charles in recognition of his great services in the development and extension of telegraphic communication.

Mr. Leyland, having been called to the chair, formally presented the testimonial to Sir Charles.

Sir Charles Bright, after acknowledging the kindness with which his friends had chosen to remember his long connection with them, said:—The chairman has alluded to the length of my connection with the company, with which I have ceased, in an active point of view, to be associated, though, as their consulting engineer, I shall still take the liveliest interest in their welfare, and it may be interesting in considering the subject from the view of telegraph progress, to remember that, at the time he and I first became connected with this undertaking—some ten years ago—the number of miles worked by the company was something under forty, while the present mileage is upwards of 4,000. The staff employed at that time did not exceed, or much exceed, a score in number, while probably 1,500 would be not far off the present number. At that time there was only one telegraph in existence in this country, and whilst the charge for a message from London to Liverpool was 8s. 6d., the messages were frequently retransmitted at Rugby and Birmingham. At the present time we have in Great Britain and Ireland something like 15,000 miles of line, and the annual receipts for telegraphic messages may possibly surprise some, even of you, who have not thought of the amount of the traffic. The total amount received in this country for telegraph messages at the present time is something as nearly as possible about £350,000 a year, a very large amount to be taken in such small sums. The extension of the land system throughout the world has been equally rapid during the same period. There is now, in addition to the 15,000 miles of line in Great Britain, some 48,000 miles of line in the United States, some 80,000 miles in Europe, and a smaller, but

* Two days after the General's death, Napoleon I.—whose head-quarters were at a distance, so that he could not have been aware of his death—created him, by a rescript, Count of the Empire, and bestowed on him a pension of 3,000 francs.

† My friend, never to be forgotten.—I cannot let pass the opportunity, which presents itself, without renewing to you the remembrance of me, and inquiring whether I am not to have the happiness before the close of my life to see once more the handwriting of my dear Baron Schilling, and to learn from him that he has not forgotten me and those around me, &c.—Your eternally, faithfully devoted SOEMMERRING.

* In the Address, pronounced by His Royal Highness, the Duke of Sussex, as President of the Royal Society, at its anniversary meeting on the 30th November, 1831, it was incorrectly stated, that Soemmerring died at Frankfort, "his native city."

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rapidly increasing, mileage in Australasia; the total amount of land lines of telegraph in the world being not far off, at the present moment, 150,000 miles. That has been the growth of a very few years. Looking forward to the future—a subject which must be interesting to all of us, who are actively engaging ourselves in the extension of telegraphic communication—although we were unfortunate in the first Atlantic enterprise, a line, the carrying out of which, from its very nature, could not be dictated by experience; yet, looking forward to the extension of a line across the Atlantic, I think we may expect, at a very short period, that that great apparent difficulty will be overcome, and that we shall have a line working direct from Ireland to Newfoundland again upon a permanent basis. Not only is that undertaking being actively pushed forward at the present moment, but careful surveys have been made for the northern route by Iceland, Greenland, and Labrador, the result of which, in my opinion, very greatly warrants the projector of that line in going forward with a view or shortening the circuits to be worked, and so reducing the risks of such a line. Again in the South active endeavours have been made; in fact, the Spanish Government are initiating the arrangements for a line to be carried from Cadiz to the Canaries, thence to Cape de Verd, and from thence to the island of St. Paul in the Southern Atlantic Ocean. There is only one stretch of 800 miles from St. Paul to the island of San Fernando-de-Noronha, and thence to the Brazilian coast is a comparatively short distance; from the Brazilian coast the line will pass along the shores of British and French Guiana to Trinidad, and thence by the train of West India Islands to the Spanish possessions of Porto Rico and Cuba. From Cuba a line will be carried to Florida, with another branch to Panama. Going south from the Brazilian coast a branch line will extend to Rio and Buenos Ayres. On the opposite side, looking towards the east, we are actively engaged in prosecuting a substantial line to India. The line made by Government from Malta to Alexandria continues in excellent working order, and its receipts so far encouraging—which, looking at the progress of these undertakings in a commercial point of view, interests all of us very greatly. The receipts upon the Government line of submarine cable from Malta to Alexandria, which opened in October with returns of £200 per week have steadily increased, until, at the present time, the weekly income is little less than £600 per week. That is a most important thing, when we consider that the communication is at present single towards the last at Alexandria, and that no return messages have yet been received from Australia, China, or India. But we are also busily engaged in pushing forward a line in continuation of the Alexandrian line, and we hope within six weeks from this time to have opened a station at the Island of Tubal, at the mouth of the Gulf of Suez, where the Peninsular and Oriental Company's boats will call, by an arrangement made with the Post-office to receive and carry on telegraphic messages to India. We have also a vessel recently equipped, and sent out from this country, with 200 miles of cable to repair the eastern section of the original line, which failed soon after it was laid between Aden and Kurrachee. Throughout India the telegraph has been extended with scarcely any limit—as, indeed, there is no limit to the construction of any land line. From Kurrachee the circuit is complete to Rangoon. From Rangoon the line will eventually be carried by Singapore and Batavia to Australia. On the other side, a line will be taken to Japan, thence to Kamtschatka, where the Russians are pushing their lines eastwards, and thence by the small chain of the Aleutian Islands to the western coast of the continent of North America. Thence it is an easy step to Vancouver's Island, which is already connected by telegraph with San Francisco. From San Francisco there is the most extraordinary line of telegraph ever constructed in the world, which passes from Sacramento by the Salt Lake City to Fort Kearney, and thence to St. Louis through an entirely uninhabited country, and by means of which the merchant in New York can now communicate directly with San Francisco. Another line will also be carried entirely on British ground through the Punchbowl Pass of the Rocky Mountains to British Canada. And thus, when these different enterprises—in some of which I am concerned—are accomplished, we shall not have a girdle round the earth, but two girdles completely round the world. I have alluded, gentlemen, thus to what is taking place at present in the extension of telegraphic enterprises, because it is one which very much affects all of us. The telegraph, as we know, had its rise altogether in this city. The first telegraph invented by Cooke and Wheatstone in 1837, was the forerunner of all telegraphs of all countries. Whether it be Professor Morse's telegraph of 1843, or the others at a later period, the type of all the instruments has been taken from the inventions at an earlier date in this country. The first submarine telegraph was laid from this city, and all the different cables have been sent out from this city. We may, therefore, look upon ourselves, to some extent, as being the nursery of telegraphs for the world; and it is, therefore, a matter of great consequence to us all to know what is going on, not merely in the mere vulgar pecuniary light, but in the business in which we are all interested.

Mr. Walsh proposed, and Mr. Blackburn seconded, a vote of thanks to the chairman, who in responding, paid a warm tribute to the zeal which had been manifested by the hon. secretaries, Messrs. R. Dodwell and W. C. Daniell, with whom the idea of the testimonial originated.

Mr. Dodwell, in acknowledging the vote, said it was a matter of great satisfaction to them to know that they had been so cheerfully supported by all their brother superintendents, and not only so but by many officers in the Electric Telegraph Company's service, (who only knew Sir Charles Bright to love and respect him,) and also by many not actually connected with the company, but who had in a great measure contributed to carry out those telegraphic extensions enumerated by Sir Charles.

Mr. Daniell quite coincided with the remarks of Mr. Dodwell, and remarked that it had afforded him very great pleasure to have rendered any assistance in the getting up of the testimonial.

The Student.

ELECTRO PLATING AND GILDING FOR STUDENTS.

ELECTRO plating is based on exactly the same principles as electrotyping in copper; but on account of the greater expense of the materials used, a mould is seldom, if ever, copied in solid silver, as is the case with copper,—but in order to give it the *appearance* of being executed in silver, a thin deposit of that metal is produced on its surface by the process which we will now describe.

The silver solution may be prepared in either of the two following ways, we recommend the latter:—

1. Dissolve any small silver coin, such as a sixpenny piece, in aqua fortis (nitric acid); the solution will have a blueish tinge, owing to the copper contained in the coin. Now add to this solution another solution of common salt in water, this will throw down a precipitate of chloride of silver. When it has settled at the bottom of the glass pour off the solution from above it, and fill the glass with water; let it again settle down, and then again pour off the water. This operation, which is called "washing the precipitate," must be repeated two or three times. Now make a solution of cyanide of potassium of the strength of about half an ounce of that substance to one pint of water, and throw into it the white precipitate, in a few minutes it will all be dissolved, and then the solution is ready for use.

2. Dissolve ½ an oz. of the crystals of nitrate of silver in about 2 ozs. of pure distilled water, and add to it a solution of caustic potash until no more precipitate is thrown down; wash this precipitate as directed in the first instance, and then dissolve it in a similar solution of cyanide of potassium, this solution being carefully prepared the rest of the arrangements are very easily set up.

On account of the costly nature of the solutions used, it is better to put them for use into glass vessels. Instead of the wooden decomposing cell recommended for the copper process, a large tumbler, or a finger glass, are among the best things which the student can obtain for the purpose, without going to any great expense about it.

A couple of brass rods can be laid over it, as was directed for the decomposing cell mentioned in our last.

The same battery may be used for the plating as was used for the copper process, and the power may be about the same, or rather less. The student will probably find it more convenient to silver his moulds one at a time, in which case a piece of wire may be attached to the back of one of them by twisting it round any prominent part near the edge, and the other end of the same wire may be twisted round the top of the zinc plate of the battery.

A piece of silver foil of about the same size as the mould to be silvered, is now to be connected in a similar manner with the copper plate of the battery.

The silver plate and the mould are now to be immersed in the silver solution; in about ten minutes or a quarter of an hour the mould will be covered with a deposit of pure silver of sufficient thickness to render it quite durable.

The mould may now be removed from the solution, washed and dried. It will however, most likely, be very dull looking; it will therefore want cleaning, which may be done by any of the modes used by the household to clean the "plate." It is an operation requiring much time and care to get a really good polish on one of these electroplate moulds; however, it may be done by that patience and perseverence which overcome all difficulties.

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Practically, where this electro plating is carried on on a large scale, the goods, when removed from the "bath" or decomposing cell, are burnished with steel burnishers.

In order to be quite successful in plating the following circumstances must be attended to, viz. :—

1. The room should not be of a temperature much lower than 60°.

2. The silver plate and the mould should be immersed in the solution and taken from it as nearly as possible at the same time.

3. The copper mould *must* be *quite* clean. In order to obtain it in this state it must be dipped in a mixture of nitric and sulphuric acids very much diluted with water, and then rubbed with a soft cloth. When it is quite clean it is best to throw it into a tumbler of water till the time comes to put it into the solution in the cell.

Electro Gilding.—If we replace the silver solution mentioned above by a gold solution, and suspend the moulds similarly attached and cleaned, with a piece of gold foil opposite them, we shall then fulfil the essential points required for electro gilding.

In order to prepare the gold solution, a small piece of that metal may be dissolved in aqua regia. A solution of caustic potass is then added. The precipitate thus formed is to be washed as directed for the silver solution, and then it is to be dissolved in another solution of yellow prussiate of potass.

On account of the great expense of this solution, it may, when the articles are small, be used in a wine-glass, as no very great distance is required between the moulds and the foil.

Any small battery may be used for the electro gilding, but the one recommended to be used on former occasions, if small enough, will do as well or better than any other. The same precautions respecting the cleanliness of the moulds given for electro plating equally apply to electro gilding. Of course the moulds are to be connected with the zinc plate of the battery, and the strip of gold foil with the copper, as was before mentioned.

The moulds may be left in the solution for about the same time as was directed for plating.

Of course any metallic object may be covered with gold by the same process, but if it be made of any metal having a high affinity for any of the ingredients of the gold solution, it may cause its decomposition, and thereby spoil it.

Electro plating is now a large and important trade, and is likely to become more so. It, however, is not carried on in exactly the same way as we have recommended the student to try it for himself, but the battery in this case is replaced by what is called a "magneto-electric engine," with a "quantity armature." This consists of a compound horse-shoe magnet with an armature rotating in front of it, to which is attached an ingenious contrivance for obtaining a continuous current in one direction from a coil surrounding the armature, on the converse of the principle of the "electro magnet" mentioned in the "Student" of the number dated, December 13, 1861. PRACTICAL STUDENT.

ELECTRICITY—ITS RELEASE.

[From a Correspondent.]

SIMPLE substances have, by electricians, been divided into two classes —electro-positive and electro-negative; basing their division upon the now well-known principle that many compound bodies, when subjected to the action of a voltaic battery, are quickly decomposed, one of the elements previously constituting a portion of the compound in process of decomposition invariably making its appearance at the point in connection with the positive pole of the battery, and another of the elements appearing in like manner at the negative. Thus it results that oxygen, chlorine, iodine, bromine, and fluorine are termed electro-*negative;* these simple bodies being always found accumulated at the *positive* point; whilst hydrogen, nitrogen, carbon, sulphur, and most, if not all, the metals are electro-*positive*, congregating around the zinc or *negative* pole.

The metals, in respect to their electric condition, seem to be pervaded by a graduated scale. Potassium, it appears, is the most electro-*positive*, then we descend in order of the metal's oxidability, until we reach gold, platinum, and rhodium. These, we are rather inclined to think, approach the electro-*negatives;* as they are not affected by the *oxygen* of any of the acids, but are at once acted upon by a mixture of nitrogen (electro-positive) and oxygen, and chlorine and hydrogen (electro-positive); that is to say, by a mixture of nitric and muriatic acids. And these metals attract the hydrogen (the electro-positive element in the liquid of the voltaic battery) more powerfully than any of the other metals, thus forming with zinc, or other highly electro-positive metal, the most energetic combination for a battery.

Chemical affinity being merely a modification of electricity, and due to the different states in which that fluid exists in various bodies, we may, by the consideration of these facts, arrive at a partially satisfactory explanation of the action that goes on in a battery during the evolution of electricity.

Zinc, it would appear, possesses electricity in a powerfully *positive* condition; for, if we insert a piece of it in a cup of water it will quickly become oxidized, showing that the powerful attraction of the hydrogen for the oxygen (forming water) has been overcome by the superior electro-*positive* attraction of the zinc for the *negative* oxygen, or the greater affinity of the oxygen for the zinc, the hydrogen escaping in a gaseous form. If, however, we attach a small sheet of copper to the zinc, and insert both in a cup of water, the zinc by its superior electro-*positive* force appears to render the copper comparatively, or *really*, *negative*, which metal then attracts the hydrogen gas to its surface.

Again, we know that all chemical compositions and decompositions are invariably accompanied by the manifestation of electricity, either negative or positive; thus then it results that by the *decomposition of the water* by the zinc, we have a certain quantity of electricity *disturbed* or *freed* for circulation; and by the *union of the oxygen with the zinc*, we have a new compound formed—oxide of zinc, which *composition* disturbs or frees another certain quantity of electricity; and the electricity so freed appears to be *positive*, as it is attracted and collected by the *negative* conducting plate, the copper, and its manifestation at that pole always indicates the presence of *positive* electricity; the zinc itself, *beneath the surfaces*, and all conductors in connexion with it, are, apparently, at the same time rendered *negative;* for at that pole all the phenonema of *negative* electricity are manifested. Possibly, the excitement of positive electricity, by the action of the oxygen on the zinc's *surface* may cause the zinc *within the surfaces* to become electro-negative, (as in the case of a glass tube excited on the outside by friction;) and will, consequently, put all conductors in connexion with it in a similar state. Immediately a connexion is made between the two poles, the positive electricity, collected by the copper plate, rushes through the conducting connector to restore the equilibrium of the forces by reunion at the negative pole. This theory receives corroboration from the facts attendant on the decomposition of water by the passage of a current of electricity through it. If we have two copper plates immersed in water, one in connexion with the copper, the other with the zinc pole of a voltaic battery, we find that although the zinc *in the battery* is the metal oxidated, the copper plate in connexion with it attracts the *hydrogen* of the water, and the plate connected with the copper pole attracts the oxygen, showing that the plate attached to the zinc is rendered electro *negative*, and that to the copper, *positive*.

The increased energy in a voltaic battery consequent upon the introduction of an acidulated liquid, seems to be caused not so much by the improvement in the conducting power of the liquid, (for an improvement in the conducting power of the liquid would also increase the quantity of electricity returned *through it* from the copper to the zinc plate;) as by the *increased quantity of oxygen* then contained in the liquid, and upon the composition of the sulphate from the oxide of zinc, supposing sulphuric to be the acid used.

When the battery is in a state of rest, that is to say, when the copper is no longer in connexion with the zinc, the copper gradually resumes its natural electro-*positive* state, and consequently does not attract the hydrogen gas from the surface of the zinc plate, which there collects in minute bubbles: and these, being unable to free themselves, cover the surface and prevent the further action of the oxygen upon it. N. E. D.

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 138.]

The paying out a long cable from a vessel, however well prepared for the purpose, offers greater difficulties than would at first sight be imagined. The cable is laid in the hold of a vessel, in as large a coil as possible, and for this purpose there are but few which will allow space enough, hence all ordinary vessels require considerable modification. The space must evidently be perfectly clear, no cross beams from side to side of the vessel can be allowed, and no perpendicular supports for the upper deck can be permitted throughout the whole of the area occupied by the cable. It is especially in steamers where so much of the hold is occupied by engines, that the difficulties in this respect are experienced. The cable must be so placed as to load the vessel evenly, and must be so paid out that she shall preserve an even keel. Consequently, when, as in some cases, the cable has been laid in two separate holds at the head and stern, in a vessel not properly adapted, portions from one and the other must be alternately paid out, and the cable be, therefore, so laid that this shift may be made with facility, and without fouling any portion of the apparatus or of the

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rigging. But with ships arranged for the purpose, and provided with large water ballast, this difficulty is not experienced. Thus the Zandvoort cable paid out from the "William Coty" was coiled in two large coils, and the paying out of one coil was completed before the second coil was commenced upon, water being admitted as required to keep the vessel in trim. When the velocity with which a cable is paid out is considered, say from four to six knots in the hour, the change above-mentioned in a heavy sea is an operation involving considerable risk, and it should, therefore, if possible, be avoided. Moreover, vessels loaded with cable are liable to roll to an inconvenient extent, especially screw steamers, which are particularly applicable for this purpose. A cable stowed in a sailing vessel and towed by a steamer is unmanageable in a heavy sea, the steering is extremely difficult, and in case of accident, it is impossible to check the progress of the sailing vessel containing the cable. It is therefore imperative, especially with a long cable, that the vessel employed should be a steamer of sufficient dimensions to contain coals, and the cable for the whole voyage. A vessel capable of laying a cable, weighing three tons per mile, across the Atlantic will have a load of 6,000 tons besides coals, and the clear space in her hold must be of sufficient dimensions for coiling this enormous length of cable. The hold must also be completely protected from the heat of the boilers. It is evident, therefore, that for such a purpose a vessel would have to be specially constructed, as no vessel existing, except the *Great Eastern*, would be adapted to the work. The labour attending the paying out of a cable is far greater than would be at first sight imagined, several relays of hands are necessary. The cable is coiled in the hold with as much regularity as possible, and each layer of coils is kept in its place by lashings of hemp, and sometimes by packings of wood for that purpose. The hands employed in freeing the coils have a difficult duty to perform. When going at full speed the coils have to be handed out with great rapidity, and yet with great regularity, to prevent their being thrown into the breaks more speedily than required; while the lashings and packings of wood have to be carefully removed, so as to liberate only so much of the cable as is required. The guides through which the cable passes must be carefully contrived to avoid the possibility of the cable getting out of the sheaves on receiving any check. It next passes through the break, which requires the most delicate handling to ensure the proper strain. If sufficient pressure be not put on the break the cable runs out from its own weight with a far greater velocity than is due to the speed of the ship, and a large per-centage is wasted.

The speed with which a cable is paid out should evidently precisely correspond with that of the vessel, and in deep water the greatest care is necessary to obtain such a result. In shallow water less difficulty is experienced in this respect; and so accurately were the steerage and regulation of the breaks under command in the first cable laid across to Holland, that though laid during a gale of wind, only 7 per cent. of cable beyond that required for the direct measured distance was laid. This operation was performed, too, in a rapid tideway, the tide being transverse to the course, first on one side of the vessel and then on the other. The steering of the vessel was never, therefore, in a direct line, but at a considerable angle to the direction it was intended to go. When it is remembered how seriously the drag of the cable over the stern of the vessel interferes with the steerage, the great care that is necessary in the navigation will be appreciated. Another difficulty occurs from the derangement of the compasses of the vessel by so large a quantity of iron in their vicinity; for although the compasses may have been first adjusted for the deflection due to this disturbance, yet as the cable is paid out, its amount varies very considerably. To meet this difficulty a separate vessel is required to guide the vessel containing the cable. In the case of the Dutch cable two tugs were employed always ahead of the vessel containing the cable. A straight course was made by these tugs alternately, and buoys were placed to make for during the day, while at night Bengal lights were exhibited from the tugs. It was, no doubt, owing to these precautions that so small a per-centage of waste took place.

The cable, after passing through the break, runs over the stern of the vessel into the sea—in some cases over a sheave, and in others through a hawse pipe. But the steerage of the vessel is far less interfered with if the cable is allowed free lateral motion over the stern of the vessel. For this purpose the rail round the stern is protected by a strong plate of cast iron, and on this plate the cable is shifted from side to side of the stern, as the steering renders it necessary. Its position requires constant changing, for the friction soon cuts deep grooves into the cast-iron plate, if allowed to run long in the same spot. The break usually employed has been a large drum of cast iron round which three or four turns of the cable are laid, the surging being affected by means of a check which guides the cable on to the drum The break is checked by an ordinary friction strap. Nothing has been found more effectual than constant personal superintendence for the regulation of this pressure, and to facilitate this operation many ingenious mechanical arrangements have been employed. The construction of the break is, indeed, a matter of the greatest importance. It is a machine which must be absolutely free from failure of any kind during the whole of the voyage, as any accident happening to the break endangers the safety of the whole operation. The laying of the cable should be uninterrupted from the beginning to the end of the journey, and with this view no derangement should be possible either in the machinery connected with the break or in the engines of the vessel. The speed, also, should be maintained as uniform as possible, and some speed always insured, whatever may be the weather. To insure this end a vessel with abundance of power is absolutely indispensable, for even the choking of a pump, the heating of any part of the machinery, the derangement of a valve, or indeed the slightest mishap in any part of all this complicated machinery, may prove the loss of the whole cable. If in spite of weather or tides the vessel could infallibly preserve a moderate speed across the Atlantic, the laying of the cable would involve but little risk. As long as the weather is calm, and all in good order, the operation is an extremely simple one, requiring only proper care and attention. But in heavy weather, when the vessel is pitching and rolling to such an extent that the men can scarcely keep their feet in the hold while unlashing and freeing the cable, the cable when the surging of the vessel throws sudden and unequal strains on the break, and more especially during dark nights when the breaksman himself can scarcely keep his place, and can see nothing of what is going on around him, the difficulty is of no ordinary kind. Paying out cable from the hold is much facilitated by an arrangement invented by Mr. Newall, technically termed the cone and rings, and described in the evidence appended. Several self-acting breaks have also been proposed and used, but these have met with only partial success.

Proposals for alterations of form from the break-wheels hitherto used will be found in the appendix; for instance, Mr. Longridge proposes that the cable should pass in a spiral groove round a cone, and that the friction on the cone should afford the necessary retardation to the passage of the wire; this friction being varied as occasion arises by varying the length of groove which the cable is made to traverse. Another plan is to pass the cable between friction rollers. Captain Selwyn, R.N., proposes to obviate the liability to kink which a coiled cable possesses by placing the cable on a large floating cylinder, which is intended to be towed by a steamer, and which would roll over in the water and uncoil the cable as it progressed. We have great doubts as to the practicability of this plan.

The question of the paying out of submarine cables and the mathematical laws to which they are subject in paying out have been already fully investigated in numerous well-known publications. We would, therefore, only observe that whilst we have described the arrangements in general use, the form of paying-out apparatus to be adopted will necessarily depend upon the cable to be used, and the depths at which it is to be laid, and must therefore be determined by the engineer in each case.

(To be continued.)

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Fine Para	1s. 11d. to 2s.	per lb.
Negro Head	1s. 1d.	„
Java	1s. 5d. to 1s. 6d.	„

GUTTA PERCHA.

Fine	1s. 9d. to 1s. 10d.	per lb.
Inferior	8d.	„

January 29, 1862. WM. KIRKMANN.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do B. 7 per cent. till 1862	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
Stock	Electric Telegraph . .	100	95 to 98	——
20	Red Sea and India Telegraph	all	19 to 19½	——
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	——
1	Do. registered . . .	all	3/8 to 5/8	——
10	Do. „ . . .	all	4 to 6	——
5	United Kingdom Telegraph .	2	1½ to 0½ dis.	——
	Mediterranean Extension Tel.	all	4 to 5	——
	London & S. of Ireland Direct.		½ to ¾ prm.	——

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Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

THE CURRENT IN COILED CABLES.

To the Editor of THE ELECTRICIAN.

SIR,—Referring to Mr. F. C. Webb's letter in your last number, I have experimented upon a length of 12¼ miles of iron covered cable dry coiled, conductor No. 16 copper, battery 40 cells sulphate, and galvanometer a horizontal suspension, and obtained the following results:—

Mean Charge.	Mean Discharge.	Mean Defect.	Mean Coil Current.
20° right.	20° left.	0°	80° right.

By using more than 40 cells I invariably obtained 90° "coil current."

Having made all arrangements, as in Mr. Webb's diagram (p. 130), with end M to earth, we have a constant current entering the cable at the battery end, and emerging from it at M, at an equal rate with the supply, after the wire is once charged.

By breaking the battery contact, and allowing it sufficient time to discharge itself at M before putting the near end to earth, the whole of the charge will escape at M, and *no* "*coil current*" be obtained. To ascertain the time necessary for this to take place, I observed that

After 3 seconds I invariably lost all coil current.				
„ 2 „	obtained a mean of	3°	right.	
„ 1 „	„	„	18°	„
„ 0·5 „	„	„	28°	„
Instantaneous earth contact „			80°	„

so that the conductor required a trifle more than 2 seconds to discharge itself and reach the equilibrium of the earth's tension. In these tests the *same earth-binding screw* was used for the two ends of the cable and one pole of the battery.

Now as the *discharge* from this cable gave 20° *left*, and the *coil current* 80° *right*, the latter phenomenon must be the effect of another current, like the primary one, in a modified form, *entering* the near end of the cable, and giving a *right-hand* deflection, and cannot be a current *coming out* of the cable through the galvanometer to the earth, for, if this were the case, the deflection would be to the *left hand*.

The question at issue, therefore, is, whence comes this second charge? it being a charge merely, a temporary, and not a permanent deflection. Permit me, therefore, to offer a suggestion. May not the cable be said to be unequally charged throughout, during those 3 seconds, and the wave, at the moment of breaking the battery circuit, be compared to a wedge, the thin end of which is toward the battery, and the thick end at the other extremity? if so, then, as the two ends are in metallic contact at same terminal screw, and are of unequal tension, would it not be reasonable to suppose that a portion of the current from the thick end of the wedge (pardon the simplicity of my comparison), would flow in at the thin end in order to create an equilibrium of tension throughout its entire length?

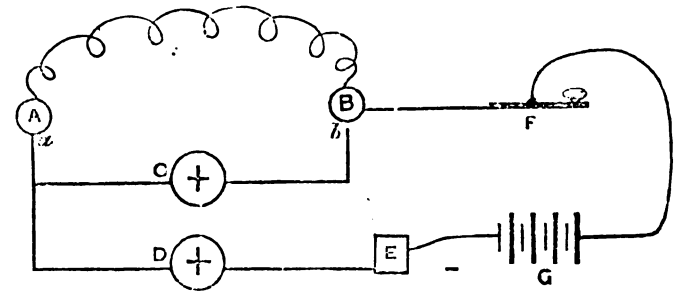
This would coincide with the observed phenomenon of a right hand deflection, because it would be a portion of the primary charge, entering a *second time* into the cable in the same direction as at first, and would gradually lessen in proportion to the lapse of time between the breaking of the battery circuit, and the making of the earth contact, as the wave would be more nearly exhausted, and less current be required to restore the equilibrium of electric tension throughout the cable, and after 3 seconds, as in this experiment, the phenomenon would disappear altogether.

Moreover, by giving an electric current two routes of equal tension it will be equally divided. Every wire or metal, in its normal state being in contact with the earth, must be of the same electric tension as the earth at that spot (*vide* p. 25). This being taken into consideration, on breaking the battery circuit, we have a cable, containing a wave of electricity moving forward, and leaving the near end of the wire (K) in its normal state, in connection with, and of the same electric tension, as the earth. On the arrival of the wave at the other end of the wire (M) it finds itself in metallic contact with *two* routes of *equal tension*; one the end of the cable K, the other the earth wire, and therefore will divide itself, and escape part into the earth and part into the cable at K, a *second time* giving a *right* deflection; the greatest perpendicular of the wave, on its arrival, causing the maximum deflection, and after that has passed, the wave diminishing in intensity, the second deflection will likewise diminish until it disappears entirely.

If it were possible to arrange a needle in such a manner as to return to zero instantaneously after this secondary deflection, it would not be surprising if a third deflection were noted from the same cause.

Being unable to arrange my instruments to obtain a proof of all the phenomena at once, I adopted the following method of determining whether a current emerging from the remote end of a charged cable would flow wholly into the earth, or whether it would divide itself, and flow part into the earth, and part a second time into the near end of the cable.

In the diagram the terminal A represents the remote end, B the near end of a cable; C and D two galvanometers; E the earth plate; F the key for breaking off the battery charge current when depressed; G the battery, one pole to earth, the other pole to key charging cable, the end A of which is insulated. Two wires, united at *a*, pass through two galvanometers, one going through D direct to earth, the other going through C direct to *b*.



After charging the cable by the key at rest, the charge is cut off by depressing it, leaving the cable charged. After an interval (proportioned to the strength of the charge and the length of the cable) or immediately, the key being kept depressed, let *a* and *b* be simultaneously connected with A and B respectively, and the result will be a deflection on both galvanometers, similar to the charge, proving that part of the current has gone to earth through D, and part has *re-entered* the cable through C to restore the electric equilibrium of the conductor, and, as I have above stated, I should not be surprised if a *third charge* were obtained, provided instruments could be arranged to register it.

If this theory be admitted, then "false discharge" is a misnomer, and some such term as "equilibrium restoration current" would be more applicable.

Mr. Webb quotes at some length the opinions of several authors (p. 123) respecting the action of the *size* of the earth as a grand receptacle of all electricity. I cannot see clearly what his intention was when he said (p. 130), "only one earth connection existed; moreover, this consisted of *great surface* being attached to the *water and gas pipes*." Whether he means the *great surface* ought to absorb, and did absorb all the original current on its arrival at M, or whether he merely mentions the fact as a proof of his having used a good earth connection, I cannot say. If he means the *latter*, it does not destroy my theory; but if the *former*, I cannot agree with him, unless he had the water and gas pipes *themselves* connected to the two ends of the cable and the galvanometer, and by *no means* connected to them by *small testing wires*; for, to say that the earth on account of its size will receive the whole of a current, while another route of equal (or more generally larger) dimensions is open for its passage, would be tantamount to saying that a tank full of water will empty itself through a small pipe into the sea, whilst another tank beside it would receive none of the water, although connected with the full tank by a pipe of greater, or equal size with that leading to the ocean, both pipes being opened simultaneously. The *size* of the earth cannot exert any extra influence upon the escape of the current from a cable, so long as its *size* is *separated* from the charged cable by a *wire of small dimensions*.

If the earth wire leading to the earth plate from the cable be *smaller* than the conductor of the cable, it will offer a greater resistance to the passage of the current on its escape at M, than the conductor itself (being in metallic contact), and the latter will gain the greater part of the current; but if the wire connecting the plate to the earth terminal be *larger* than the conductor, then it will offer less resistance, and the earth will have the advantage. In either case, the current will be divided, more or less equally, varying with the proportionate resistance between the earth wire, and that of the conductor; unless that earth wire be of extraordinary size.

Again, Mr. Webb says, "we may have such a combination of conditions, that either the '*static charge*' or the '*coil current*' may predominate."

Static charge (p. 121) is the current flowing into a wire until it is filled. Since the *secondary deflection*, which he terms "coil current," is but a *part* of the primary, or static charge, how is it possible, *under any circumstances*, for a *part to exceed the whole?*

Further, he states, in the case of the 70 miles hemp covered core, the needle was held over for several seconds by the "coil current." Can a strong (or any) induction current, similar to this, be produced by a core, insulated from the earth in the hold of a ship, and containing *one metal only?* Will this not rather agree with the theory I have propounded? The long length of 70 miles would contain a long wave of electricity, and before the divided current was entirely exhausted, would produce a continued flow of current into the near end of the cable, "keeping the needle over several seconds" to the *right*, quite irrespective of any "inductive action between the convolutions of the coiled conductor."

I fear, sir, I am trespassing too much upon your valuable space, but the earnest wish of several correspondents that the question should be investigated urges me; and although I have criticised Mr. Webb's letter, it is not done with any hostile feeling, but with a view to call attention to what may be a reasonable theory, and in doing so, I trust that I am only

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advancing the ends we all have in view, viz., the advancement of science and the discovery of truth. J. G. LT.

January 23rd, 1862.

To the Editor of the ELECTRICIAN.

SIR,—Anent the subject of my last letter I can suppose some one saying, "Oh yes, it is all very fine to preach about the porosity of gutta percha, but 'Momus' must get a different text; for even admitting it porous to the extent represented, it has still the advantage over rubber that it can be applied to the wire far more efficiently than the latter can, an advantage which outweighs immeasurably the alleged defect of porosity.

There is undoubtedly a notion abroad that unless a wire can be enclosed in the insulator while in a pulpy state, so as to be by that means embedded in a solid mass when the insulator resumes its natural condition, that there is no other possible way of efficiently insulating the wire: an assumption just as reasonable as to suppose that because granite rocks are hard the sculptor has no means of producing from their adamantine blocks the exquisite creations of his godlike genius. As far as gutta percha is concerned, far be it from me to say that the plan alluded to is not a good one, save and except that there is a possibility, nay a certainty, of sometimes getting the wire anywhere but in the centre of the insulator. I have seen gutta percha covered wire seventy-five per cent. more on one side than the other; it *may be* preventible, but I am informed it happens not unfrequently.

And so because *this* method of coating the wire is scarcely feasible with caoutchouc, a queer sort of illogical conclusion is arrived at, that the system of insulating adopted by certain india rubber manufacturers is necessarily defective; hence we hear ever and anon, that the system of covering the wires with successive layers of rubber run on spirally is a never failing source of defect, which translated into English means that there will, of necessity, be interstices between the laps, or where the edge of one lap impinges on the preceding one; so that a current of electricity, in passing through such a covered wire would suffer a greater amount of waste in a given number of miles, than through the pores of the gutta percha as before described. Now all this sort of thing betrays an amount of ignorance scarcely to be expected at the present advanced stage of telegraphic knowledge; an ignorance culpable and inexcusable, if not as wilful and intentional as when, in apparently utter unconsciousness of his presence, you turn the cold shoulder on your quondam friend who has not been quite so successful in the race of life as yourself.

Why, it is well known that this method of applying the rubber by overlapping the wire spirally one layer above another is effected so well by one firm as to constitute the very perfection of insulation; for by the use of a powerful solvent in the process of covering, the insulator, when completed, becomes one solid homogeneous mass, with the wire necessarily in the centre, from the fact of its rotatory motion during the process; and not the least unimportant fact is, that although this solvent has the magical effect of causing the successive layers of rubber to fuse into a compact and impervious coating, it is yet unattended with any deleterious influence upon the insulating medium.

It may in truth be inferred, from the foregoing, that most delicate manipulation, and machinery denoting a high degree of attainment in mechanism by the inventor and manufacturers, were necessary in order to produce so efficiently an insulated wire. And indeed, nothing can well be imagined more perfectly and exquisitely adapted for the important work it has to do than the machinery in question; one layer of rubber follows closely upon the heels of the preceding one, while self-acting cylinders supply the requisite quantity of solvent fluid, as the thin tapes of rubber pass through them; so that the putting on of three or four coatings is effected as easily, and in almost the same time as the putting on of but one; and the wire, as far as insulation is concerned, comes off the machine perfect without having to undergo any second operation.

The escape of electricity on a wire so insulated is almost nil, so perfect and compact is the covering; but of course in this, as in all things else, a great deal depends upon the quality of the material used, but as this may form a subject for a future letter, I forbear to make further allusion to it here, except that I ground the foregoing statements as to the perfectibility of a core so constructed, upon its being made of the best materials.

Now even supposing that gutta percha were, in every sense of the word, as good an insulating material as caoutchouc, it still remains a conclusive fact that the application of the latter to the wire in the manner above described, is immeasurably superior to the method in use for coating a wire with the former.

Having thus shown, as I flatter myself I have, that gutta percha is a very porous material; and secondly, that although a tolerably good insulator, it labours under the disadvantage of being a substance that cannot very easily be applied to the wire so as to ensure its uniform central position; while caoutchouc, on the other hand, has, comparatively speaking, no perceptible pores, and the wires it encloses always uniformly central, when insulated as above described; I leave further considerations for some future occasion, and am yours respectfully, MOMUS.

[We cannot see that our correspondent has *shewn* that gutta percha is a "very porous" material; albeit, the fact of its porosity to a certain extent may be generally admitted.—ED. E.]

To the Editor of THE ELECTRICIAN.

SIR,—Allow me space to offer a few observations on the article in your last number signed "Scrutator."

First, I must remark how inherent it is in our nature to determine those faults in others which we are unable to recognize in ourselves: I am not aware that I made any statement, much less one of a special character, which might produce an uneasy feeling with regard to the produce of "other manufacturers;" my article I leave as yet unattacked by "Scrutator," and to stand the criticism and remarks of far better judges: at any rate I have not fallen into that unfortunate state, which I pity in "Scrutator," as to take such liberties with any one's name as he has used with "Mr. Chatterton's!"

Whatever may be the feeling of rival manufacturers there is a respect to be observed in handling their names.

Ambition often tempts us to show our folly; "Scrutator's" No. 1 contains nothing original, he has neither shown my errors, nor pointed out what insinuations have been made with regard to "other manufacturers." Much less has "Scrutator" shown "that your correspondent 'Insulator' is not conversant with the manipulation of the gum in question."

With due respect to Messrs. Hall and Wells' manufacture, I have yet to learn that by their *modus operandi*, the desiderata for good insulation are fulfilled.

But to conclude (with an apology for this intrusion, Mr. Editor), I inform "Scrutator" that when he has proved his right to the name which his vanity has led him to adopt, I shall be ready for his observations.—Yours, etc., INSULATOR.

January 24th, 1862.

THE BATTLE OF THE INSULATORS.

To the Editor of THE ELECTRICIAN.

SIR,—On reading the remarks in your last number, under the above heading, by your correspondent, "Investigator," I am compelled to differ from him, generally, on many important particulars, and I am quite satisfied that he cannot be at all acquainted with the subject, or that he must be influenced by dealing largely in gutta percha, if this be so, the public cannot be surprised at the remarks made by him. Your correspondents, "Insulator," and "Scrutator," are evidently men who are guided by facts, and in addition to those opinions and statements we have the Government Report to guide us, as far as the experiments were carried up to the date of publication; but with regard to the "sweet repose" of the advocates of gutta percha, I suppose it means, that the quantity already used, for the purpose of telegraphy, must have produced such a large profit, to those interested, that it matters very little to them now, whether india rubber wins the battle or not, for utility or usefulness.

But, sir, this is most important, after the very many failures we have had, entirely through using gutta percha as the insulator, and the external coverings of cables being constructed upon the elongating, or spiral principle.

Thus far the battle has been all on one side, in consequence of the delay in not using india rubber for some years past.

But surely sir, we must, in future, be guided by established facts, and take care to use the best article that can be produced, to secure perfect insulation, this desideratum cannot be over-estimated, when the great sacrifice of capital is considered, and the influence it has on public confidence in telegraphic enterprises, and might it not be truly said that monopoly and want of genuine experience in the practical, and mechanical knowledge, required in the proper construction of a submarine cable has been the primary cause of many failures.

But the time cannot be far distant when capitalists themselves, will take the necessary means of ascertaining before risking their money in any proposed company, constituted of men who will not faithfully and truly perform the duties they have undertaken, without being influenced by any existing monopoly or self interest in pandering to the powers that are already much too powerful in all existing companies, as, if this could be effected, there would very soon be an end to the battle of the insulators, as india rubber has been decided, and generally acknowledged by those who ought and do know, the superiority it posseses when compared with gutta percha as an insulator.

So that with regard to the best method of applying the caoutchouc on the wire there need be no discussion, as it will not be very difficult for any practical telegraph engineer to discover the appearance or non-appearance of decomposition. I believe there are some J. R. cores that have been manufactured upwards of three years, and have been exhibited for that time, so that it will be very easy to make comparisons with gutta percha cores manufactured at a similar period.

I doubt not that durability ought to be well considered, and the above proof will very much assist in arriving at and deciding upon this point, so that the many doubts "Investigator" has on his mind will be easily solved, and he will be able to make himself acquainted with the time it will take to obtain free trade in the telegraphic enterprises of 1862, which I am much inclined to assert will be the date to settle the "Battle of the Insulators."—I am, sir, yours most obediently, CITIZEN.

January 28th, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—A distinguished foreigner, in recording his experience of a lengthened residence in England, relates, among other stories, that a young lady of rank, with whom he was intimately acquainted, set the etiquette, &c., of her rank at defiance, by marrying her father's footman; upon the strength of which he broadly asserts, that a similar disposition of being

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enamoured of every imaginable species of flunkeydom characterizes the generality of the young ladies of the English nobility.

Your correspondent of last week, "Investigator," forcibly reminds me of the above.

There is the unquestionable fact of certain india rubber covered wires having suffered from decomposition; *ergo*, india rubber is a bad insulator, and ought not to be used. Such is the impression which "Investigator's" letter is intended to produce, not, as he insinuates, from the antagonists of rubber, but from its *redoubtable champions themselves;* a crafty way of putting the csse, but neither ingenuous nor candid; but, fortunately, meets its refutation in the very article from which he draws his inferences.

"Scrutator" merely alludes to a fact which it would have been absurd to ignore, in order to show that a decomposed india rubber covered wire were an *avoidable* and *unnecessary* occurrence, and details under what circumstances the rubber should be applied to produce the desideratum required, truly a work of superorogation for the matter of that, since wires, perfectly insulated with caoutchouc, are now an accomplished fact; having been in existence for years and stood every imaginable test of high temperature, &c., without the slightest deterioration. Indeed caoutchouc insulation has made such rapid progress in public favour as to warrant the belief that the time is not far distant when gutta percha will be generally superseded by it.

With respect to the article signed "Insulator," whom your correspondent ranks among the supporters of rubber, it would be hard to tell from his communication whether he were so or not. He shows under what circumstances rubber decomposes, that is about all, in language rather too scientifically stilted to be of much use to ordinary readers (I trust "Insulator" will pardon me).

The circumstances under which rubber decomposes are precisely those which operate so disastrously upon gutta percha. If the wire be damp, or the tapes of rubber when applied, oxidisation is caused, the wire corrodes, and the gradual destruction of the insulator is the inevitable result. Gutta percha perishes, *but more rapidly*, under the same influences. But there is this important difference between the two materials, you cannot apply the latter to the wire without first reducing it to a pulpy state; hence you *always* run the risk which terminate so fatally as above described. On the other hand, there is no earthly necessity for getting your wire or anything else damp in order to insulate with rubber, the drier the better; hence decomposed india rubber covered wires are only a proof of bungling and inexperienced application, and not a necessary result.

The "suicidal fray," "divided camp," &c., having existence only in the fertile imagination of your correspondent, it would be sheer waste of time to notice; except to warn him against the delusive hope of a "sweet repose" for poor "old Gutta," however ardently he may desire it. While at the same time, even from a "battle field," truth is not unfrequently eliminated.

FAIR PLAY.

Miscellanea.

THE ATLANTIC TELEGRAPH COMPANY.—Mr. George Saward, of the Atlantic Telegraph Company, has addressed a letter to Mr. Cyrus W. Field, of New York, urging the expediency of reviving the project of the Atlantic cable.

TELEGRAPH AND WARFARE.—The American correspondent of a contemporary, alludes to the patronage of the commander-in-chief of the American army, in the following words:—"He has made the fortune of Cyrus Field, who is brother-in-law of M'Clellan's old patron (and perhaps his own), by giving him a contract to run telegraph wires along the coast."

THE PRESERVATIVE QUALITIES OF CAOUTCHOUC.—We quote the following interesting notice from the *Chemical News:*—"*Wood for Ship Building.*—Professor Crace Calvert is now making an investigation for the Admiralty of different kinds of wood used in ship building. It appears that the professor is at no loss to explain why so many of the fleet of recently built gun-boats became rotten and others escaped untouched. He finds the goodness of teak to consist in the fact that it is highly charged with *caoutchouc;* and that, if the tannin be soaked out of a block of oak it may then be interpenetrated by a solution of *caoutchouc*, and thereby rendered as lasting as teak. Of the durability of teak there can be no question."

ELECTRICAL PRODUCTION OF THE HYDRATES OF SILICIA AND ALUMINA.—M. Becquerel, who for the last thirty years has been occupied in researches with the object of reproducing the minerals and crystals of nature by electrical decompositions and recompositions through feeble voltaic currents, has submitted to the Royal Academy some important results obtained by currents of high tension. In this case it appears necessary that the solutions submitted to electrolysis should be perfectly pure; and that, as in electro-plating, a constant current of a determinate "quantity" should be employed. The two first substances acted upon were the silicate and aluminate of potash. From silicate of potash M. Becquerel has produced beautiful opals, hydrophanes, and other crystals, endowed with all the properties of those found in nature. From the sulphate of alumina he has obtained a hydrate of alumina identical with *diopside;* and he does not despair of obtaining from the hydrate of alumina the topaz, corundum, and sapphire.

TELEGRAPHIC EXPEDITION.—The speech of His Imperial Majesty the Emperor of the French, consisting of some 1,200 words and 6,200 letters, was transmitted from Paris to London in 30 minutes, by the Submarine Telegraph Company. Four wires and four sets of instruments were employed.

THE LONDON AND SOUTH OF IRELAND DIRECT TELEGRAPH COMPANY.—The share list of the London and South of Ireland Direct Telegraph Company will be closed next Saturday, the 1st of February, except for Ireland, which will be open till Monday, the 3d of February.

THE BATTLE OF THE WIRES.—Midleton, a small place in the County of Cork, was on Monday last the scene of a grand contest between three telegraphic companies who contended at the presentment sessions for the the honour of carrying their wires on poles over the barony of Imokilly. The Engineer of the Universal Private Telegraph Company, was the first to claim the privilege that he might establish direct communication between Cork and Queenstown, and between the south-east coast of Ireland and various towns in South Wales. Mr. J. M'Cartie, on behalf of the Eletric and International Company, undertook to show that his competitor was sailing under false colours, and could not perform all he promised, whereas the company which he represents had the map dotted with its stations, had spent enormous sums laying down lines, and had a capital of nearly £1,000,000. Then started up Mr. Gillman, for the British and Irish Magnetic Company, denying that either of his rivals had the power they pretended to serve the country, which power belonged exclusively to the company he had the honour to represent. He was backed up by Mr. Sanger, the Dublin secretary. Lord Fermoy, who occupied the chair, and who is chairman of the South of Ireland Direct Telegraph Company, said:—"With regard to the South of Ireland Direct Telegraph Company, all I can say is that it is a *bona fide* concern. We propose to improve the telegraphic communication between the South of Ireland and London. The money is provided, and if no impediment is thrown in the way by this or any other barony, our wire will be at work by the 1st of May, or soon after. It is now for the sessions to say whether they will grant the permission or not." Colonel Roche then proposed that permission be granted. The motion was carried unanimously.

AT A MEETING of the board of directors of the Electric and International Telegraph Company held on Tuesday last, it was resolved to recommend to the proprietors at the general meeting to be held on the 6th of February next, a dividend of £3 10s. per cent. for the last half year.

THE CONDUCTIVITY OF SALINE SOLUTIONS.—M. Marie-Davy has recently been engaged upon an investigation into the laws of Conductivity of Saline Solutions. His researches are detailed in the *Comptes Rendus* for October, 1861. He operated upon nine different solutions of sulphate of copper, in distilled water, the density of which varied from 1·018 to 1·177, that is from an extremely weak solution to one that was saturated. He found that the conductivity of such solutions was equal to the sum of the conductivity of water and the salt, and that it was proportional to their respective densities, the temperature remaining the same. He considers that the water and salt act as separate conductors; that each is traversed by its own peculiar current; and that each is consequently decomposed. The copper reduced has a double origin, one resulting from the direct electrolysis of the current, and the other resulting from the secondary action of the nascent hydrogen. The presence of a free acid in a solution adds a third conductor to the two others, and diminishes the proportion of copper directly reduced. Lastly, the electromotive force of a Daniell's battery varies with the concentration and neutrality of the solution of the sulphate of copper.

A TRAPPIST named Delalot-Sevin, of the Abbaye de la Grâce-Dieu, has made a discovery which will probably produce a revolution in the system of lighting and heating public and private buildings. He has invented a new pile, much stronger, and at the same time much cheaper, than the pile of Bunsen. By means of his photo-electric apparatus he produces an electric light as cheap as gas, and with his thermo-electric pile he supplies caloric on economic terms hitherto unknown. Several of these apparatus have been constructed, and one is at full work in the Abbaye of La Grâce Dieu. Manufactories for the public are shortly to be established in Paris and at Lyons. The apparatus for producing gas will not be given to the public until after the Exhibition at London this year. The inventor has been authorized to make public experiments with his system of lighting on the Place Saint Jacques in Paris, and on the Place Bellecourt at Lyons.

To Correspondents.

*** In consequence of a number of woodcuts being required for the continuation of the article by Mr. F. C. Webb, this is unavoidably postponed until next week.

A STUDENT.—We could not answer your questions, without being acquainted with the method of construction adopted in the apparatus you refer to. You would probably find the information required in "Noad on the Induction Coil."

ABROAD.—Clerks have been sent from this country to India, Australia, and the Cape of Good Hope. We believe, however, that most of the telegraphists at present employed are natives of those dependencies and colonies. The East India Company had a school in which youths about to proceed to India, were taught the art of telegraphing.

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The Electrician.

Vol. I. No. 14.—February 7, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 146.]

23. The first means naturally suggested for discovering the direction of passing electricity is simply to look at the spark and see; but this, under ordinary circumstances, one may attempt in vain, for the energy of the electrical attraction is so great, and the motion of electricity consequently so rapid, that the electrical spark presents, like any other luminous thing very quickly moving, the appearance of a continuous line, beginning and ending at the same instant of time at every point of its course. We may present two knuckles of separate hands to the opposite balls of the revolving machine, and thus cause electricity to pass in two seeming currents; and those appearances will continue so long as the cylinder is in motion. Judging from what would thus be visible, we might suppose that electricity passed from both the balls to us, or from us to them; we should detect nothing from which we might infer its direction. All we could say with certainty about it is, that while electricity is passing *to* us at one side it is passing away *from* us at the other; for if it were not so, we should have to regard the machine as capable of giving out, or taking in, an unlimited quantity of electricity, which not only our theory but observation also denies; for if *two* currents could perpetually pass out or in, *either* of them could do so; but, instead of that being true, we find on making trial that the passage of electricity when one of the knuckles is presented almost immediately ceases on our withdrawing the other. What observation does for us in this case is, therefore, limited to proving that the machine cannot be perpetually either giving off, or receiving, electricity at one part, without perpetually doing the opposite thing at some other.

Exp. 6. Fix a long pointed wire into each of the balls of the machine, so that the two extend in opposite directions, and turn the winch. A star of light will tip one of the wires and a brush of rays the other, suggesting the idea of an entrance of electricity by the former, and an emission of it by the latter, but actually convincing us that the two points are doing different things, both of them neither giving off nor receiving it.

Exp. 7. Place a ball an inch in diameter with a short stem and broad foot, all of brass, upon the plate of an air-pump, and cover it with a clean and dry glass receiver, through the top of which the stem of another similar ball passes so as to allow of the receiver remaining air-tight. The balls should be in a vertical line, and about an inch apart, every part of the receiver and pump-plate being distant from them at least three inches. By means of two brass chains or wires connect the pump-plate with the ball of the machine which carries its cushion, and its opposite ball with the stem on the top of the receiver. Pump the air from the receiver as perfectly as possible, and then put the cylinder in motion. Electricity will pass between the brass balls, and surround the lower one with a luminous atmosphere, conveying the idea of the arrival there of electricity in a mass, and its diffusion over a solid surface before entering it; but, as in the preceding experiment, plainly indicating the discharge of electricity by one of the substances, and the receipt of it by the other.

24. These indications of the direction of the passing electricity ought not at present to be considered conclusive, because we do not yet know what appearances electricity may be expected to present when it enters or quits metallic balls or pointed wires; they are simply suggestive, but we can obtain better evidence from facts of another kind. We have already felt, and consequently know, that electricity is capable of inpinging on our knuckles, and although we cannot tell by our sensations into which knuckle it is entering, and from which it is emerging, we cannot help associating with those sensations the idea of mechanical violence; and reason tells us that if electricity be capable of communicating a mechanical impulse to our material organization, it should be able to do it also to matter generally. Cannot we then look to see whether bodies receive such an impulse, and if so, which way they are propelled by it, when we introduce them into the path of passing electricity? We will show that this may be done, although there is something very deceptive requiring to be guarded against in doing it, which is this: inasmuch as all bodies in their natural states contain both electricity and common matter, they may be equally acted upon both by positively and negatively electrical charges, and be moved by them indiscriminately. On this account an object may actually pass under the force of attraction in a direction opposite to that in which the electricity may be moving. This circumstance renders almost nugatory the indication of a variety of experiments devised to show, by the mechanical agencies of electricity, which way it passes; but it occurred to the late Mr. Singer to balance the attractions of the two substances between which the electricity was made to pass, and thus he succeeded in submitting an interposed body to the undisturbed mechanical impulse of the passing electricity.

Exp. 8. Construct a light float wheel by accurately inserting six or eight vanes of card paper, two inches long and half an inch wide, at equal distances into the periphery of a disc of cork, that turns freely on a fine needle passed exactly through its centre, and having its ends supported within two glass beads cemented near the tops of long sticks of sealing-wax that rise vertically from a wooden base. Two straight brass wires, each fastened to the top of another stick of sealing-wax supported by the same stand, are to be arranged in a line with one another, their inner ends being sharply pointed, and reaching to within an inch, or somewhat more, of the upper parts of the vanes at their respective sides; the two distances being as nearly equal as it is possible to make them. When the outer ends of the wires are put into metallic communication with the balls of the machine, one with each, and the winch is turned, the vanes fall over towards the ball that carries the cushion, indicating by the mechanical impingement made upon them a passage of electricity in that direction.

25. When the above experiment is made with due care all the interfering circumstances by which its legitimate result might be vitiated, are so effectually excluded, as to confer upon its indications a claim to perfect confidence; but not to lay too much stress upon any single experimental indication, all the conditions of which may not be understood, let us explain that in this, and in every other case, we shall rely more on *the consistency of our inferences one with another, and the efficiency of the whole as a causative system, than upon their apparent correctness individually.* It is very easy for the judgment to err with respect to what an isolated fact implies, but after we shall have found an inference to be a necessary part of a satisfactory system, the probability of its error will have then become infinitesimally small. With respect to the present one we shall now merely add that soon we shall have to account very precisely, and on the principles of our theory, for well-known differences in electrical sparks, and also in the conditions under which they will pass when we present uninsulated conductors to the two large balls of the revolving machine; and then we shall be in a position to put the electrician into the dilemma either of rejecting all the evidences we

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shall, up to that time, have accumulated in favour of our theory as a whole, or of admitting that the ball in connection with the amalgamated cushion of the machine has been made by the revolving cylinder electrically minus, and its fellow ball electrically plus.

Perhaps, though, we should not altogether pass over in this place Wheatstone's beautiful experiment in which electricity seemed to arrive at the end of a long conducting wire before it had got to the middle of it; such an event being, of course, impossible, the experiment might be supposed to warrant an inference against the doctrine of a single electricity, but those who may think so can hardly adduce it as favouring the idea of two electricities, each setting out simultaneously at its own end of the wire and meeting with the other somewhat later in the middle of its length; because such an inference would not accord with the known indications of the galvanometer. Now this want of synchronism cannot be accounted for on the doctrine of two electricities; but we shall prove it to be a natural consequence of there being only one.

26. But until we shall have made the necessary progress we can only work with inferences as they separately present themselves; we have already some collected; and we shall now use them to add to their number. We have seen reason to conclude, that the electricity which is attracted by all common matter is itself material; that in its normal state of distribution it is invisible because its particles, then divided, are too minute to be objects of sense; that it becomes visible by its particles coalescing into sensible masses when they isolate themselves from common matter; that being attracted by common matter in definite quantities, whenever one body becomes plus or positively electrical by gaining it in excess, some other body must become minus or negatively electrical by losing it; and that in the case of the glass cylinder revolving against the cushion faced with amalgam, it passes to the cylinder from the cushion, and from the cylinder to the conducting ball on the opposite side. Hence the latter is named the plus or positive conductor of the machine, and the ball which applies the cushion its minus or negative conductor. To these conclusions, derived from our theory and observation, we must add others that reasoning, based upon them, renders obvious; inasmuch as particles of electricity, when left to their own reciprocal action, coalesce into masses, they must draw one another together, or, in other words, attract one another, and as positive and negative electrical charges in bodies must be coexistent, and as the plus electricity of the former and the negative common matter of the latter can never cease to be reciprocally attractive, bodies having those relations, will always tend to be as near to each other as possible, that being the purpose and very nature of what we call attraction.

27. We shall find the attraction of the particles of electricity for each other, thus introduced into our system, to be of the utmost importance, connecting together the sciences of electricity and gravitation, and deriving support from almost every part of the subject we shall have to treat. We must delay its consideration for a time, merely remarking that the idio-electrical repulsion of the old theories, whose place it takes, is a force no longer needed either for distributing electricity upon the surfaces of bodies, or for the dispersion of its particles in a vacuum as heretofore supposed. All these subjects will be considered in their proper places.

28. It will also, by and by, be an interesting subject of inquiry how bodies possessing definite quantities of electricity, naturally, can have those quantities altered while their attractions, which are also definite, must remain unchangeable. This inquiry we must at once prepare ourselves for by first learning the conditions of the normal electrical rest, or static equilibrium; and that involves an investigation of the laws of the electrical force, to undertake which will need that we add to our machine some other pieces of electrical apparatus.

(To be continued.)

THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.

[Continued from p. 148.]

The principal instrument-room of the Station in Telegraph Street presents a unique and most interesting picture. Seated opposite their instruments, albeit for the moment some may be reading or plying their needle, are upwards of one hundred young ladies, appearing quite at home in the performance of duties which to the uninitiated would doubtless appear to require the utmost exercise of the perceptive and concentrative faculties. The room, which is 80 feet long by 37 broad, is lighted from the ceiling; the operators facing the north, in order to secure a uniform and subdued light necessary for deciphering without fatigue the "dots and dashes" upon the long strips of paper unrolled from the receiving instruments. Of a truth we cannot imagine a more cheering scene to those who recognize the necessity in this country of organizing suitable employment for females—without the sphere of their ordinary domestic avocations—than that of these young ladies engaged in an intellectual and apparently congenial employment. We are glad to state that their comfort and well-being appear to be carefully studied. They possess a separate means of entrance and exit, and a refectory to themselves; and are under the guidance of a lady bearing the title of Chief-Matron.

Accompanied by the Electrician and Engineer to the Company, we have followed up-stairs the wires proceeding from the battery cellars, which, by means of other "boxes," with suitable binding screws, can be connected with the various instruments and line wires. The wires in the office are all hidden from view; nothing being required or seen in the instrument room but the terminal brass screws through which the connections are made. Along the tables or desks, however, the ends of the insulated wires make their appearance through small apertures, and can be attached to or detached from the instruments. The lady "instrument clerks" have, in the case of lines of any considerable length, four different pieces of apparatus in their charge, viz.:—The Galvanometer; the Relay-magnet; the Receiving Instrument; the Transmitting Key.

The galvanometer serves to indicate the force of the two currents, from the near and the distant battery which traverse the wire. It is composed of a piece of magnetized steel, poised horizontally upon a knife edge, and surrounded by a coil of wire. The magnetized steel carries an upright pointer, which shows upon a scale the degree of deflection of the magnet occasioned by the passage of the current through the coil. The latter is compound; there being, in fact, two coils of wire of unequal length, constituting a double galvanometer the needle of which is influenced to an equal extent by the two currents of unequal power traversing the respective coils. The "arrival current," weakened by loss of tension and leakage passes through the longer coil. By simply inspecting the galvanometer, the *employée* can at any time ascertain the amount of battery power necessary for the transmission of signals, or detect the existence of a "fault" of sufficient extent to endanger the correctness of transmission.

The relay-magnet serves to bring into operation a "local battery" for the purpose of working the receiving instrument; the latter requiring generally a far greater power than could be communicated by the arrival current. This current is therefore made to influence an electro-magnet; the armature of which is adjusted with great delicacy, in close proximity to the poles. When the arrival current traverses the coils of the temporary magnet, the armature is attracted; and its movement causes the powerful current from the local battery to be "turned on" to the receiving instrument. When the arrival current is cut off at the distant station the armature is removed from the temporary magnet by the action of a spring. This, however, applies only to the ordinary system of working lines, in which relays are employed, by a succession of currents in one direction only, or from one pole of the battery. In the system of working by "reverse currents," introduced by Mr. C. F. Varley, and employed by the

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Electric Telegraph Company, the spring is advantageously dispensed with. The relay consists of an electro-magnet, the core of which is moveable inside its helix, the latter being fixed. The core is delicately mounted on pivots, and its extremities play between the poles of fixed permanet magnets of horse-shoe form. When a current is passing through the helix, the iron is temporarily magnetized according to the direction of the current. The one current deflects the iron and closes the local circuit. The opposite current deflects the iron core in the opposite direction and opens the local circuit, thus performing the part of the spring in the ordinary relay. The advantage of such an arrangement becomes obvious when it is considered that slight vibrations, or "accidental currents" along the line, are often sufficient to overcome the resistance of the spring, and thus to produce at the receiving station signals which may seriously interfere with the working of the line. Again, in working by reverse currents, i. e. *in breaking the circuit of the local battery by means of a negative current, instead of by the cessation of the positive current which brings the local battery into operation*, the relay-magnet becomes self-regulating. When a spring is employed for retaining the armature of the electro-magnet, its resistance requires to be constantly re-adjusted according to the variations in the power of the current, the increased power developed in the magnet by the repeated currents, and the various disturbing influences acting upon the line wire. In the system of reverse currents, the force which retains the armature is always proportionate to that which causes the local circuit to be completed, moreover the former instantly ceases when the latter is brought into operation. Another important advantage of this system is, that from a given number of cells of the battery twice the force is obtained to actuate the relay. Equally important advantages in the working of long lines are secured in Mr. Varley's system, which, however, do not enter into our present subject-matter.

A simple but admirable contrivance is adopted for preventing the vibration of the delicate relay magnets. A heavy rectangular mass of iron is enclosed in a wooden box, mounted upon supports of vulcanized caoutchouc. Upon this the instrument is placed; and, by reason of the difficulty of producing vibrations in a heavy mass supported upon an elastic material, it is thus withdrawn from such disturbing influences.

The receiving instrument used with the relay on long circuits, and occasionally worked on shorter circuits by the current from the distant station,* is that which is generally known as the Morse instrument; but has undergone some modification at the hands of the engineer and electrician to the Company. The signals are produced by the action of an electro-magnet; the armature of which carries a lever, one end of which, when the armature is attracted by the magnet, impresses the "dots and dashes" upon a long strip of paper moved through the instrument by the agency of clockwork. From this strip the message is transcribed in writing.

The lever-key is a very simple piece of apparatus for transmitting a succession of currents along the line. The signals are sent by depressing one end of a brass lever, either by a momentary pressure producing a "dot" upon the paper slip at the distant station, or for a short space of time, in which case the "dash" is impressed. In its normal position the lever obeys the influence of a spring, and establishes the communication between the line wire and the relay or receiving instrument. When depressed, the key brings the line wire into communication with one of the poles of battery. In Mr. Varley's system of transmission the lever when released establishes a momentary communication between the line wire and the earth, in order to facilitate the discharge of the wire, and also causes a reverse current to be transmitted.

Our attention was directed to what appears to be a very efficient and economical method of working a circuit of moderate length, in which several stations are included, by means of one battery at either of the extreme stations; whereby the expense and trouble of a battery at every station is avoided. In this system, when the line is not employed in transmission, a continuous current from the battery is allowed to pass, permanently deflecting the galvanometers at all the stations. When a message is to be transmitted from any station the operator at this point interrupts the current along the wire, or breaks the circuit, by moving a small brass lever attached to the key; and immediately all the galvanometers along the line return to zero. By making and breaking the circuit, signals can now be transmitted as usual. It has occasionally happened that the operators at two of the stations have, simultaneously, broken the circuit and commenced the transmission of a message, in which case the signals along the line are of course unintelligible. This incident, however, can only be of rare occurrence. It might be supposed that the continuous action of the battery would be attended with a great expenditure of material. This however does not appear to be the case; the increased consumption of zinc in the production of voltaic effect, being compensated in great degree by the diminution of *exosmosis* of the copper solution in the porous vessel of the battery cell, while the battery is in action,—the escape of this solution and its action upon the zinc element being a source of waste which in practice is greater than the legitimate wear and tear of the battery.

For communicating with the telegraph lines of the various railways the single and double needle instruments are almost universally employed.

The Continental messages are forwarded and received in a separate room by gentlemen possessing the greatest experience in practical telegraphy and well acquainted with the languages of the Continent. Thus, Mr. Fischer, who has charge of the instrument department, possesses an intimate acquaintance with the leading Continental languages. It may be of interest to some of our readers to make some mention of one or two messages which were forwarded and received on our account. At the request of Mr. Varley intimation was given to the telegraph clerk at Amsterdam that visitors were in the London office, and a question was put relative to the state of the weather. The answer was immediately transmitted to the effect that at Amsterdam it was raining, and that the streets were "very muddy;" the weather being there similar to that which prevailed at the time in London. The time at Amsterdam was exactly fourteen minutes past three; that at London being five minutes to three—showing a difference of nineteen minutes, corresponding with the difference in longitude of the two towns. A message was then sent to Berlin, through relays at Amsterdam and Hanover. It was ascertained that at Berlin "fine spring weather" was enjoyed, the temperature being 48° Fah. The time at London was 3 p.m., at Berlin, 3.54 p.m.

A very high speed of transmission may be obtained even upon the longest lines by the system of reverse currents to which we have referred. This system, which provides for the complete "discharge" of the wire, or the neutralization of the surplus electricity after each signal, is not adopted on the Continent, the ordinary system being still adhered to. The Electric Telegraph Company's submarine wires which are connected with the wires of the various continental Governments on the other side of the ocean, are worked by another form of Varley's key, in which a momentary reversal of the current is effected.

A peculiar and interesting translator, constructed by Mr. C. F. Varley and employed on the Continent, enables the continental single-current system to work with the reverse current (or Electric Telegraph Company's) system, and *vice versâ*; the operators at each end not even perceiving the change of the system. In lines of moderate length a greater speed of transmission is obtained with the double-needle than with the printing instrument, but with much greater fatigue to the operator when the communication is continued for a long space of time. It must be remembered, moreover, that the double-needle instrument necessi-

* Bain's instrument is also employed. This is similar to that of Morse, but marks the dots and dashes by the action of a steel point, transversed by the current, upon a chemically prepared strip. The signals are thus marked of a blue colour.

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tates the use of two separate wires. On the occasion of the transmission from Glasgow of a speech by Mr. Bright, containing 25,000 words, a trial was made of the degree of speed respectively obtained with the double-needle and printing instruments. At the onset, the former instrument was found to possess the advantage in point of speed, after half an hour the instruments were equal in this respect, but at the close of the contest the printing instruments were working with by far the greatest speed; the operators upon them being comparatively free from fatigue. The average rate of transmission upon the printing instrument employed with reverse currents and relays may be stated as 22 words. On several occasions the Queen's speech to the Houses of Parliament has been transmitted from London to Liverpool at the rate of 30 words per minute.

(To be continued.)

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

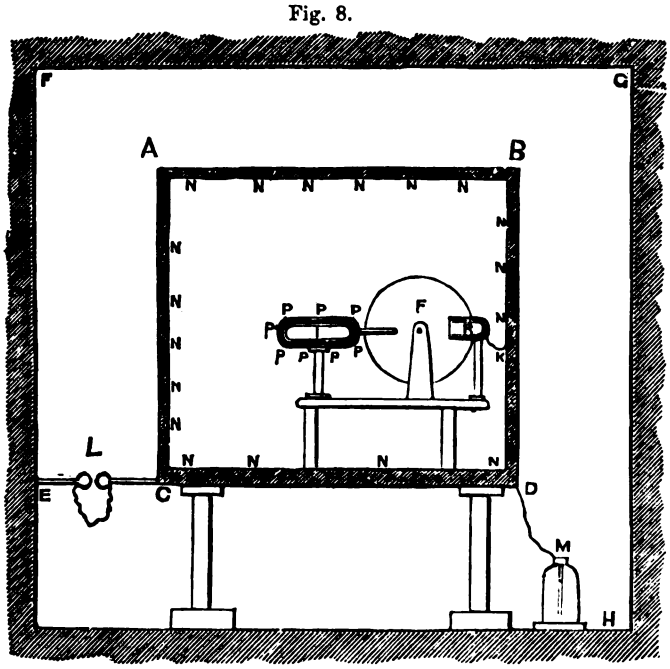
BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 138.]

I will now describe an experiment which I consider, and which I think will be allowed to be, a fair test of the truth or error of my views.

Suppose A B C D (fig. 8) to be a room of some conducting material, insulated on supports inside another room, E F G H. Suppose I to be the prime conductor of an electrical machine F, placed within the room A B C D, and let the rubber R of the machine be connected to the room by a chain R K. Now if the size of the earth has an influence on the distribution of electricity in the manner described in received explanations, then we shall obtain different effects within the room A B C D, if it be insulated from the earth, to what we should obtain, under otherwise similar

Fig. 8.



conditions, when the room is connected by a conducter C E to earth. For instance, if we tried to charge the prime conductor, since according to the received explanation, the negative electricity is divided with the whole surface of the earth when connected to it; then as it can no longer divide itself with the earth, by reason of its being no longer connected with it, we should not obtain the same effects as those which would follow when it is connected with earth. For instance, the degree of accumulation on the prime conductor would be different; for all the writers I have quoted attribute the increase of effect that is produced on the prime conductor when the rubber is connected to the earth in some way with this connection between the rubber and the comparatively infinite body of the earth.*

Again, if we performed experiments with two condensing plates,—since in the received explanations there is always at one stage of the experiment a flow of electricity to earth, we should for like reasons obtain different effects when the room is insulated.

Again, suppose we were first to connect the room to earth and charge the prime conductor I, and afterwards insulate the room. Then if we connected the prime conductor with the insulated room, since its charge can no longer "*be shared between it and the whole surface of the earth,*" but only with the room, the quantity remaining on it should not be "inappreciable," and the conductor ought not (according to Messrs. Walker and Lardner's theory), to be restored to its natural state.

Again, if the electricity tends at all to pass to the earth through the conductor C E, when attached, we could by proper means obtain indications of the passage of the electricity from the room to the earth. For instance, if the conductor C E be broken at L leaving a small space as shown in the figure, a spark should at some time pass at the break.

If, however, as I believe, the action goes on entirely between the *outer* surface of the prime conductor and the *inner* surface of the room, or in fact, on the *surfaces* which *bound* the insulating medium, and consequently is entirely confined to within the room, none of these indications outside should take place, and we should be able to perform all our experiments within, equally well, and with the same results, whether the room be connected to the earth or not. We should be able to charge the prime conductor to the same density, we should be able to accumulate electricity on a condenser, and finally by connecting any charged conductor within the room to it, we should obtain *absolute* and complete discharge, and all would be reduced to the normal state. These would be a decided proof that the size of the earth plays no part in the various electrical actions which, in the received explanations are never solved without recourse to the size of the earth as the main cause of the effects observed.

It might be imagined and advanced by any one supporting the old theories, that although no actual conduction could take place between the insulated room and the earth, and that thus no actual flow of electricity could take place to the mass of the earth, yet that some sort of electrical effect would be produced exterior to the room, as, for instance, if the room became, in its thickness polarized, thus having its exterior surface in a positive state to the interior surface, producing again an opposite state in the interior of the outer surrounding room E F G H.

And, indeed, Professor Daniell in one of his foot notes (page 246) in describing "an insulated electrified ball" placed within an *un*insulated metallic sphere,† after pointing out that the particles of the dielectric within would become polarized, goes on to say, "strictly speaking the sphere itself will be in a polarized state, but the electricity on its other (*i.e.*, its outer) surface of the same name as that of the interior ball, will be virtually annihilated by being in metallic communication with the indefinitely large surface of the earth."

From the latter part of the quotation it would appear that Professor Daniell held that if the shell *were* insulated from the earth it *would be* polarized. According to my views of the case there is not sufficient information specified in the words "an electrified ball" to determine whether the shell would or would not be polarized when insulated. It would depend on the conditions under which the ball was first electrified. For instance, if the ball A (fig. 9) were electrified when placed outside the shell, by a source S, one pole of which is connected to earth, or to the outer opposing surface E F G H, and then insulated and placed in the shell at A′, the latter would in such case be pola-

* My own explanation of the difference produced by connecting the rubber to the surrounding objects will be found further on.

† *Shell* would be the most appropriate term for the hollow metallic body implied.

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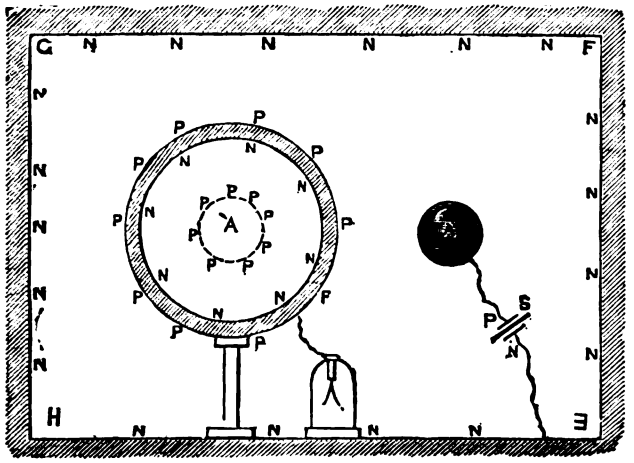
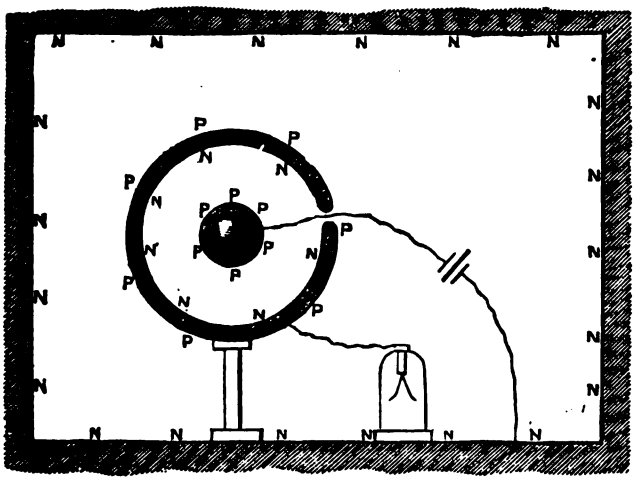
rized, and the electrical state that would ensue is represented by the letters. Or if the ball was inside the insulated shell, and

Fig. 9.



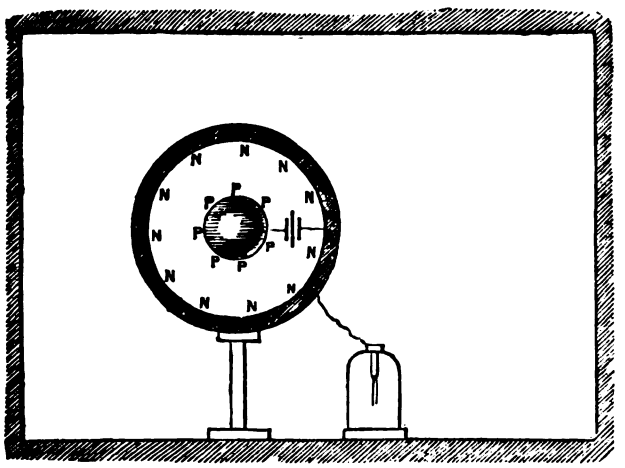
electrified by being in connection with one pole of a source having its other pole connected to the earth, as in figure 10, still the

Fig. 10.



shell would be polarized. But if the ball being inside the shell were electrified by a source having one pole connected to the shell, as in fig. 11, then no polarization of the shell, I maintain, could take place, no matter whether the shell be *insulated* or not from the *earth*.

Fig. 11.



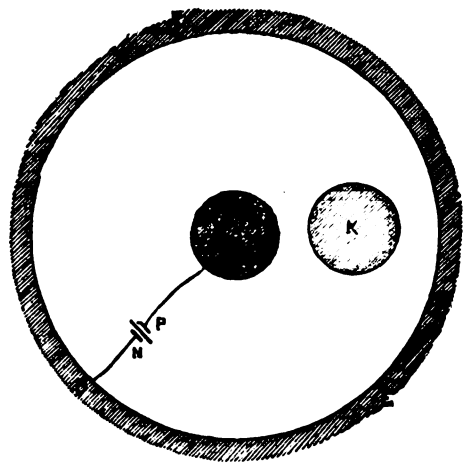
The latter, therefore, is a similar case to the "insulated-room" experiment I have suggested, the performance of which would determine the truth or error of my views. If when the room is insulated it should become polarised, its outer surface becoming positive to its inner, the outer surface would indicate this state, and a gold leaf electroscope M attached to it, as represented in fig. 8, should diverge.

I shall now proceed to describe, on the position I have thus advanced, the various forms which the conditions for accumulation may assume.

The case of a sphere in the centre of a hollow conducting and opposing surface, on each of which equal quantities of electricity of opposite nature are accumulated, is the simplest case of accumulation. It may be termed conveniently *charge* by *direct induction*, or simply *charge direct*.

Suppose now a sphere A of conducting material (fig. 12), surrounded by a conducting surface D E C F be joined to the posi-

Fig. 12.



tive side of a source, the negative side of which is joined to the surface D E C F. Then A would become positively charged, and D E C F negatively. After having charged and insulated A from D E C F, let another insulated and uncharged sphere K be introduced between A and the surrounding conducting surface. Then an action will take place, by which the electrical state of the sphere K will become altered, its surface next to A will become negative, and the surface nearest D E C F positive. The conductor K has become polarized. Furthermore, the inductive resistance of the dielectric being diminished in the direction A C by the displacement of so much insulating and inducting medium as is displaced by the conductor K. the distribution of the electricity on the sphere A and the outer surface D E C F will no longer be uniform, an increase of density will take place on the parts of those surfaces in immediate proximity to K, at the expense of a decrease of density on the other parts.

If two spheres be placed in a line between A and the outer surface they will in a similar manner become polarized; if a large number be imagined in every direction round the sphere A, their state will approximate to that in which the particles of the dielectric are supposed by Professor Faraday themselves to exist.

This might be conveniently termed *intermediate polarization* by *induction*. It is, however, the phenomenon which has perhaps been the first to which the term electrical "*induction*" has been applied. It has, however, always been assumed that this is an action simply caused by the conductor A acting on the sphere K, through the agency of the dielectric, the action on the sphere K of the negative charge on the outer conductor, never entering into the explanations.

If several spheres be placed round the sphere A, they will, as I have said, become polarized. If now, instead of a number of spheres, a single complete hollow spherical conductor enclosing

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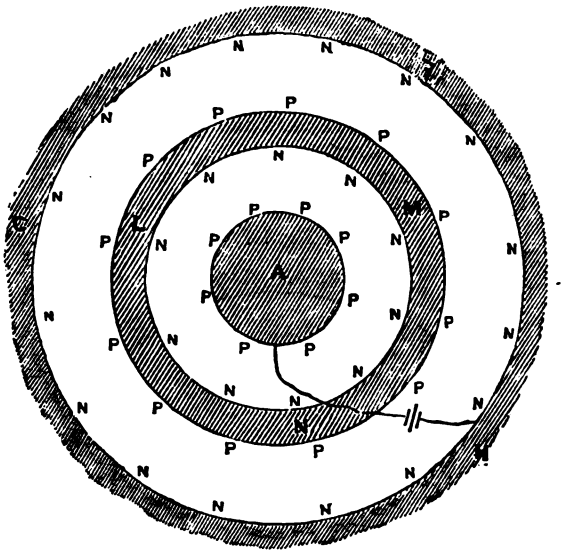
the sphere A, could be inserted within the outer surface, as in fig. 13, and separated from both by a stratum of dielectric, the whole of this spherical conductor L M N, would become polarized in lines radiating from its centre, or in fact the whole of its inner surface will become negative to A, supposing A positive, and the whole of its outer surface positive to the surface F C H.

Fig. 13.



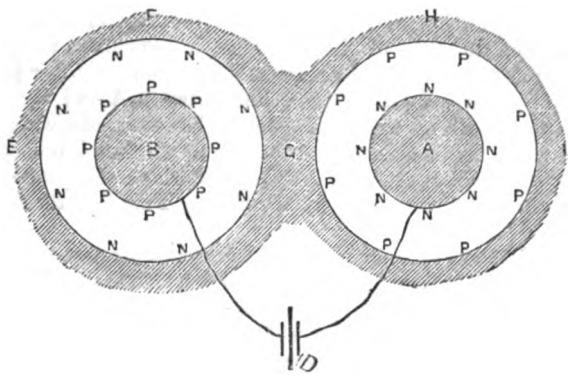
If such an arrangement be established previous to charging A, the charging of A and F C H can still be effected, and that to even a higher density with the same source than if the inductive action took place from A to F C H solely through the intervening dielectric. For the inductive resistance is diminished, and, as we shall see further on, this, with a given source, will allow of a higher degree of accumulation.

It is evident, therefore, that the inductive action between the opposing electricities on the conducting surfaces in connection with the two sides of a source, can take place by the mutual action of both on the surfaces of an intermediate conductor, separated from them by a dielectric, on which both electricities can freely induce, and which thus becomes polarized.

So long as we maintain these conditions, we may alter the arrangement of the conducting surface of the intermediate conductor with the production of similar effects.

Suppose A and B (fig. 14) to be two conductors in connection with the opposite sides of a source D.

Fig. 14.

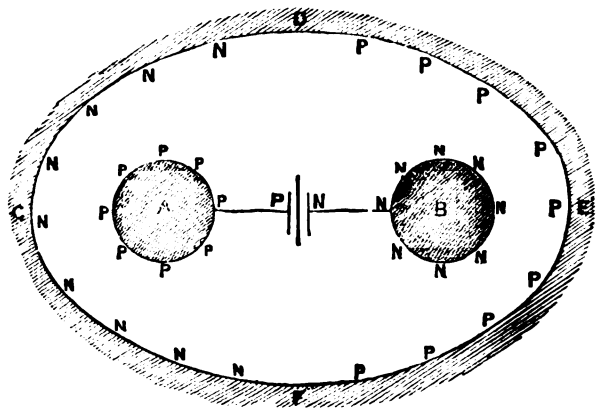


Let A be in connection with the negative pole, and B in connection with the positive pole. Let these conductors each be surrounded in every direction by a mass of conducting matter, E F G H I, which shall also intervene between the two, and which is separated from each by a stratum or shell of dielectric. Then A and B will be in a position to induce through the dielectric on the surfaces E F G and G H I of the common conductor E F G H I. The surfaces of the two conductors A and B become charged therefore with electricity of the same name as that of the pole to which they are connected, whilst the surrounding surfaces E F G and G H I of the common opposing conductor become in an opposite state to the surface of A and B. Thus, A being negative, G H I will be positive; and B being positive, E F G is negative.

Conducting surfaces in connection with the two sides of a source are, therefore, under conditions for causing accumulation from that source, not only when a dielectric alone separates them, but when there exists what may be termed an "intermediate" or "common" conductor, which is separated from both primary surfaces by dielectric. These are therefore what may be termed cases of *accumulation by indirect induction*. It is not necessary that each primary surface be opposed by totally different and separate surfaces of the intermediate conductor. They may be opposed by different parts of the same surface of the intermediate conductor, and thus a combination of *direct* and *indirect* inductive action may occur.

For instance, suppose A and B (fig. 15) to be two conductors connected as before to the two sides of a source, A to the positive, and B to the negative, and surrounded by an opposing surface, C D E F, of a mass of conducting matter or each

Fig. 15.



intermediate conductor from which, and from one another, they are separated by a dielectric. Then each of the conductors A and B can induce directly on the other in the direction A B, and indirectly each to the surface C D E F, which would thus become negative at those parts F C D, most proximate to A, and negative on those parts D E F, most proximate to B. This might be termed *compound induction*.

An infinite variety of combinations may, it will easily be seen, occur. (See figs. 16, 17 and 18.)

In all these cases the electricity separated by the inductive action, on the common opposing conducting surfaces, occurs always in equal quantities of positive and negative electricity. Thus in the case represented in figure 15, the quantity of positive electricity induced on D E F, will be exactly equal to the negative on D C F.

Again, in fig. 14, the quantities on the surfaces E F G and G H I will be equal; and again in the fig. 13, the quantities on the interior and the exterior of the polarized shell, L M N, will be equal and opposite.

In every case the quantity of each electricity induced is exactly equal to the quantity which directly opposes and induces it; but this in all cases does not necessarily consist of the whole charge on the conductor on which the inducing force exists.

In those cases, for instance, in which any direct induction takes place between the conductors in connection with the two sides of the source, (as in fig. 15,) the electricity induced on the outer opposing surface is not equal to the total quantity on each of the conductors: for some of that quantity is due to the direct action

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which takes place between them, and which does not therefore act on the opposing surrounding surface.

Fig. 16.

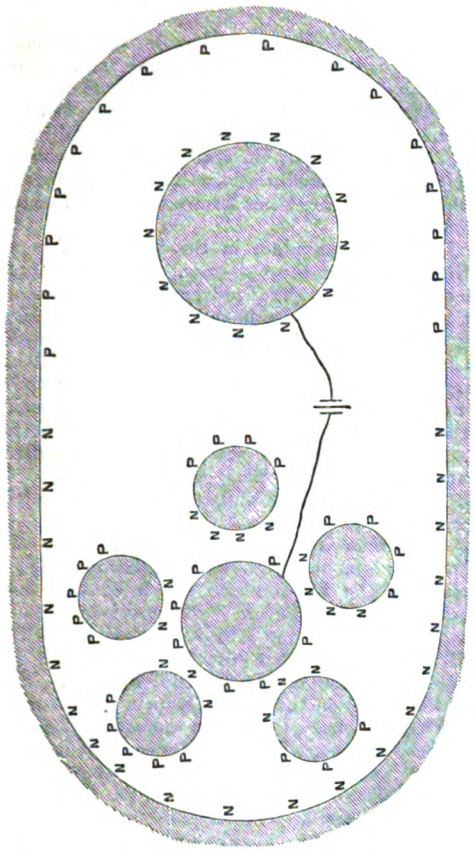


Fig. 17.

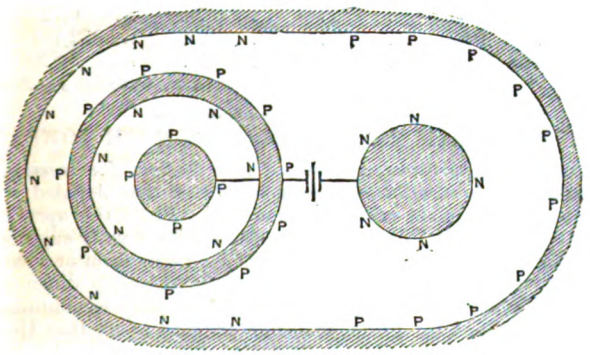
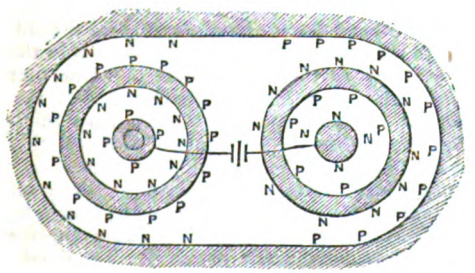


Fig. 18.



Where, however, there is no direct action between the conductors in connection with the two sides of the source, as in figs. 13 and 14, the induced charges on the outer opposing surfaces are exactly equal to the charges on the primary conductors to which they are opposed. Thus the induced charge on E F G, fig. 14, is equal to that on B.

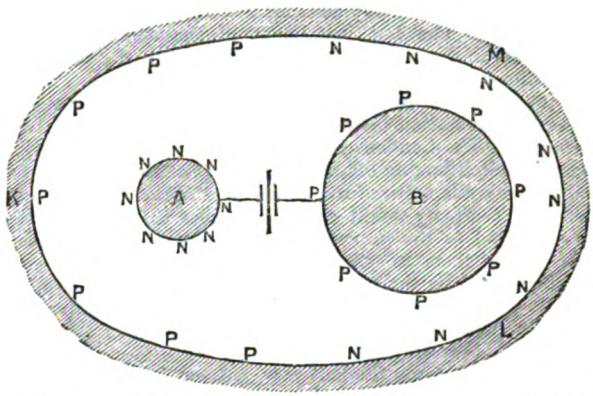
If A, therefore, (the source D having been removed,) be connected to E F G by a conductor, these two equal quantities of opposite electricity will neutralize each other by recombination without in the least affecting the electrical state of A and its outer opposing surface. There remains, therefore, on A and its opposing surface, equal quantities of opposite electricity, which will neutralize one another when allowed to recombine by conduction.

In the same way the charge on A (fig. 13) will be equal to the induced charge on the interior of L M N, and if these be allowed to recombine by conduction, the electric state of the exterior of L M N and C H F will remain unaltered, (provided the source has been previously withdrawn.)

In the case of the compound induction, Fig. 15, if we connect one of the conductors, B, to the outer opposing surface, the induced electricity of opposite name to the charge of B will be neutralized by an equal portion of that charge; leaving a quantity on B, which, together with the induced electricity around A on the outer opposing surface (and which is of the same name as B), will exactly equal the charge on A. When A is connected to the outer opposing surface, these two will neutralize one another.

It has been stated as a fundamental axiom that the quantities generated must always be equal. Whatever disproportion exists between the conducting surfaces in connection with the two sides of the source, this axiom still holds good. Thus, in figure 19, if

Fig. 19.



A and B be two unequal conductors, connected to the two sides of the source, the quantity on each will be exactly equal; the density on B will be much less, therefore, than that on A; the induced electricity on that part of the surrounding conducting surface, K L M, opposite B, will be also equal and opposite to the portion induced around A.

In any of these cases, when the two primary conductors which have been charged by connection with the two sides of the source, are joined by a conductor, their charges neutralize one another; and the primary cause of the electrical disturbance in the opposing conductor being thus destroyed, the two equal quantities of induced electricity recombine and reduce all to the normal state.

The quantity which is produced in any of these cases, and how this quantity may, with a given source, be raised by an alteration in these conditions for accumulation, will be pointed out further on.

(To be continued.)

REPORT OF THE DIRECTORS OF THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.

The result of the eventful six months just closed is on the whole satisfactory.

Depression arising out of political causes has affected business at many of the commercial stations. The tariff with the Continent, at the corresponding period of last year, was higher than at present, and during the last six weeks of the year the introduction of the shilling rate between London, Birmingham, Liverpool, Manchester, and other

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places, which was forced on the company, has destroyed all profit on those circuits.

Under such circumstances, it is gratifying to the directors to report that the general traffic of the company has continued to increase, and that the receipts for the last half-year exceed those of the corresponding period of 1860 to the extent of £4,140. The expenses, on the aggregate, show little variation, except in the item of law charges, which the directors were reluctantly compelled, for the protection of your interests, to incur. The result is a net profit of £37,777 against £35,117 in December, 1860. A dividend for the half-year of £3 10s. per cent., now recommended, will absorb £28,975, with a surplus of £8.802, to be added as usual to the fund for the renewal of submarine cables; leaving untouched the balance of £6,362 (undivided profits on previous working) to be carried forward to the credit of the current half-year.

The renewal fund with interest, and the above appropriation, will consequently amount to £50,545. The time has arrived for utilizing it. The increase of business with the Continent, and the prospects of a still further progress from the extensions towards the North of Europe and India, have forced on the directors the necessity of providing additional means of transmission. The present Zandvoort and Scheveningen wires have continued to work satisfactorily, and the company has happily been free from casualty on these and on the Irish cable during the half-year; but they will soon prove inadequate for the expanding traffic without incurring delays which it is alike for the credit and interest of the company to avoid. The Board have therefore entered into a contract with Messrs. Glass and Elliott to make and lay an additional and greatly improved cable, with four wires, between England and Holland, for the sum of £56,000. This cable will be more powerful than any yet laid down, and will afford the means of undertaking any additional work which can be reasonably anticipated. The last instalment of the contract price will become payable in January, 1863, before which time the whole charge of this additional cable will be met out of revenue.

Recent events have brought prominently forward the necessity of improving the connection between London and the South of Ireland, and a company (The London and Queenstown Direct, Limited), with a sufficient capital, having offered, entirely at their own risk, to lay and maintain a cable between the coasts of Pembroke and Wexford, provided this company would carry land lines to Queenstown, your directors assented to the proposal, and have made a call on the new shares to enable them to effect the object, in accordance with an agreement executed by the two companies. The traffic is expected to be remunerative on the outlay to be incurred, and the importance of the object in view made it desirable that the extension should be in connection with your system.

The board have, during the half-year, entered into further arrangements with the West Midland Company, under which the telegraph is being extended over the Worcester and Hereford and Severn Valley Line. Agreements have also been made with other companies, which will be found detailed in the Electrician's Report.

Allusion has already been made to the Shilling Tariff introduced by the new company. This, on the long circuits, has proved as predicted, a failure, and all the companies competing at these rates are suffering a daily loss. How long this loss is to continue does not depend on your board. It is certainly less onerous to you than to others, and the directors are in hopes that in time wiser counsels will prevail, and that a fair and moderate remuneration, in proportion to the service performed, may ultimately be secured. This unnecessary sacrifice has not, however, deterred your directors from pursuing the policy on which they have for years acted, of affording to the public such judicious alterations of tariff as the circumstances of the company warrant them in introducing. A general reduction to all places of considerable traffic within a circle of 300 miles has therefore been determined on. The directors cannot hope that the sacrifice thus made will be immediately compensated by increased business, but, relying on the experience of previous years, they are sanguine that at no distant period the loss will be recovered by additional traffic, for which they are amply prepared; and they are anxious, as heretofore, by every means at their command to extend and cheapen the public service, satisfied that by a continuance of a liberal policy they will improve your property by placing it on a still sounder basis.

The following directors retire by rotation at the present meeting, and being eligible, offer themselves for re-election: namely, Mr. Bidder, The Earl of Caithness, Mr. W. F. Cooke, Mr. Mark Philips, Mr. Richard Till, and Mr. Joseph Whitworth.

Robert Grimston,
Chairman.

28th January, 1862.

Electrician's Report.

Gentlemen,—I am happy to be able to report to you that your lines and circuits throughout the kingdom continue to work very satisfactorily.

During the past half-year a considerable sum of money has been expended in the renewal and repair of poles, and in every case the work has been done in a substantial and durable manner.

Throughout the half-year considerable attention has been paid to the re-arrangement of your existing circuits, and direct wires have been provided between towns, the traffic of which is on the increase; and other advantageous modifications have been made. In many cases the printing instrument has been profitably substituted for the needle instrument.

No alteration has taken place in the working of your submarine cables to Holland during the half-year. As at the date of my last report, three of the wires in the Zandvoort cable continue to work in the most satisfactory manner, and one of the Scheveningen cables is also in good order. The fourth wire in the first-named cable still remains out of use, as it has been decided that it would be injudicious, so greatly dependent as we now are on this cable for communication with the Continent, to run the risk of damage, or even of temporary interruption to the other working wires. The repair of this wire has been accordingly postponed until your new cable to Holland has been submerged and brought into work.

Your cable between Holyhead and Dublin, and your Isle of Wight cable, continue in good working order.

The following works have been completed, or are in progress. Erection of telegraph on the Eden Valley Railway; the Lowgill and Ingleton branch of the London and North Western Railway; the Worcester and Hereford and Severn Valley sections of the West Midland Railways; the Malton and Thirsk, Malton and Driffield, York and Market Weighton, and other branches of the North Eastern Railway, and several branches of the Midland Railway. The telegraph has also been completed on the South Durham and Lancashire Union Railway, and an additional wire erected thereon. The erection of the telegraph has been commenced on the Inverness and Rosshire Railway, and the work of providing a telegraphic communication for the Admiralty between Pembroke Dockyard and St. Ann's Head is being prosecuted with all despatch.

Your wires have also been extended to Lower Thames Street, and into the centre of the City of Oxford, and offices opened at each place.

Your present mileage is as follows:—

Miles of line	6,727
„ wire	32,787
No. of Instruments	3,529

Cromwell F. Varley, *Electrician.*

MEDITERRANEAN EXTENSION TELEGRAPH COMPANY.

The report of the directors says:—"The receipts for messages as compared with the previous half-year have more than doubled, whilst the expenditure has not materially increased. Since the opening of the Alexandria line in November last, the traffic has greatly augmented, and is still increasing. The shareholders are aware from previous reports, that the directors have experienced considerable difficulty in securing a systematic transmission of telegraphic communication through the Italian Kingdom, but they are glad to say that there is at length a probability of their efforts being successful: the Italian Government having entered into arrangements which, when completed, will, it is believed, secure the object in view. The attempt made by Messrs. Glass, Elliot, and Co. for the restoration of the old submarine cables failed, and there is now little hope of success in that direction. It will be satisfactory to the shareholders to know that their new cables—the one connecting Malta with Sicily, and the other connecting Corfu with Otranto—continue to work most efficiently. The directors have lately received information, through the company's agent at Turin, that it is the immediate intention of the Italian Government to lay a submarine cable connecting Sicily with Sardinia, by which means the route *via* Naples, Rome, &c., which has been the cause of so much difficulty and delay will be avoided, and a more regular and speedy communication obtained. The usual payment of the dividends on the preference shares is recommended. The directors regret that they cannot announce a dividend on the original shares for the past half-year. An examination of the company's position will show that the prospects of the company are more cheering at the present moment than they have been for a long time past; and the directors confidently hope that the operations of the company for the current half-year will enable them in August next to declare a dividend on the original shares."

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PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	1s. 11d. to 2s. per lb.
Java	1s. 5d. to 1s. 6d. „

Gutta Percha.

Fine	1s. 10d. to 2s. per lb.
Inferior	8d. to 10d. „

February 5, 1862. Wm. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	
20	Do B. 7 per cent. till 1862	all	18 to 20	
20	Do. C. „ „	all	9 to 11	
Stock	Electric Telegraph . .	100	96 to 100	
20	Red Sea and India Telegraph	all	19 to 19½	
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	
1	Do. registered . .	all	3/8 to 5/8	
10	Do. „ . . .	all	4 to 6	
5	United Kingdom Telegraph .	2	1¼ to 0¼ dis.	
	Mediterranean Extension Tel.	all	4 to 5	
	London & S. of Ireland Direct.		¼ to ¾ prm.	

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

To the Editor of The Electrician.

Sir,—"Tremble, and tuck in your truculent tails, ye host of 'anonymous scribblers,' hang your recreant heads, and down upon your marrow-bones, in suppliant attitude, miserable men, before the mighty oracle 'P. Q.'"

Such were a few of the words which involuntarily flowed from my pen after reading the letter of "P. Q." in the Electrician of the 24th January. With your permission, sir, I propose to make a few brief remarks upon that letter.

As a preliminary, however, I would beg to ask a question. Was "P. Q." the name given to your correspondent "by his godfathers and godmothers in baptism"? if not, why ape such supercilious contempt of "anonymous scribblers, since he ranks foremost amongst the motley fry?

But to proceed. Mark the magnanimous condescension of his opening lines, "I am quite willing to concede to your correspondent 'Electrician,'" &c. Truly "Electrician" should rejoice unfeignedly in having mollified the wrath of such an opponent.

And then the second paragraph, so characteristic of the man, "I cannot agree with your correspondent," &c. How should he? Does "P. Q." ever agree with any one? It may chance that an "anonymous scribbler" may agree with *him*, but that is a different thing; the happy nonentity may then bask in the sunshine of "P. Q.'s" urbanity.

"Practice what I preach," was the dictum of one of the chaplains of the Fourth William, to his parishioners, with the addendum, "and not what I do." Let us hope, however, that "P. Q." has no occasion for the latter part of the sentence, that he is never "illogical" nor "unreasonable," that his "facts" are always "carefully selected," the "experiments" he details "well conducted," and the opinions he expresses "logically argued:" still the dictum is astonishingly bold, and should only proceed from infallibility. Well, and why should not "P. Q." be infallible?

Of course it is perfectly natural your correspondent should throw the *onus* of the Atlantic cable failure upon Mr. Ford, Mr. Whitehouse, or any other alleged inexperienced gentleman that had to do with it, rather than admit any defect in the insulation, or compromise his darling gutta; but is he really so green as to suppose that the public will be blinded to the real facts of the case by a handful of scientific dust? "He who runs may read," it was a manifest job, any one else may bear the blame, the constructors are quite content to have borne the cash. Really if those persons who have nothing to lose but everything to gain, whether the cable succeeded or not, if they cannot speculate upon the probable causes of its failure with philosophic calmness, who, in heaven's name can? Unquestionably gutta percha had nothing to do with it, we have "P. Q's." testimony that that is the very thing; and what could be better for the Red Sea and Mediterranean? And we all know what an excellent commodity it is for shipment to Rangoon.

I am much gratified to hear, and on such excellent authority, that electrical matters are discussed with such "gentlemanly courtesy" and "philosophic spirit" at head quarters; doubtless the mantle of their courtesy has fallen upon the shoulders of "P. Q."

The mention of "india rubber" evidently throws your correspondent into convulsions, and the "whispered word" "monopoly" does not mitigate the symptoms.

If the inimitable "P. Q." has really no difficulty in "grasping the substance of every theory detailed," as he modestly affirms; why then if he have a spark of benevolence in his composition he will forthwith sit down and render the said theories into intelligible language, for the benefit of the present writer and a whole bevy of similar numskulls. Let me urge this matter upon your correspondent; it is really a fine opportunity, such a one indeed, as may never occur again during the term of his natural life, for the exercise of abilities and development of powers which he undoubtedly possesses: he might acquire the gratitude of thousands, and "cover himself with glory." True, he may urge what a sheer waste of time it would be to write for such a shallow-pated race, a "casting of pearls before swine." Perish the thought! is not "P. Q." a courteous gentleman? Lucky fellow! the Fates were propitious at his birth: we of the lower grade, while envying his infinitely intellectual superiority, cannot but look up with wonder and admiration. How delightful it must be thus to dwell among the gods. Momus.

January 27th, 1862.

To the Editor of The Electrician.

Sir,—In the number of your Journal for January 17, I find the following, among other remarks in an editorial note, *in re* Smee's batteries.

"Electric clocks have been worked by a couple of plates, zinc and copper, simply buried in the earth." On reading this, a question suggested itself to my mind, which I should be glad to have answered either by yourself or some one of your many scientific correspondents. It has been stated to me that in all voltaic batteries there is a certain, although perhaps a small, loss of electrical force, for practical purposes, consequent on the *return of the current from the copper to the zinc plate through the liquid employed in the battery*. Such being the case, and taking for granted that the earth is a *prime* conductor of electricity, how is it that any current whatever should be found to traverse through the coils of the clock work to the zinc pole, instead of returning directly *back through the earth?* The earth being in contact with the front, back, bottom, top, and sides, or rather edges of the plates, I must confess myself puzzled to know why the electricity does not, as usual, choose the shortest route. The "polarization" of the earth's particles surely cannot render it a *non-conductor*.

N. E. D.

P.S.—I think your correspondent "P. Q." would do more credit to himself, and better verify his statement that he "knows of no question which has not been discussed by eminent scientific men with *gentlemanly courtesy*," &c., if he were to use more courteous and gentlemanlike language than that contained in the portion of his letter in reply to "Momus," published in your number for January 24th ult. Not including himself among the "*eminent* scientific men," perhaps he avails himself of the freedom of exception, and writes merely as an "humble *labourer*."

[The views of our correspondent respecting the origin of the voltaic current are imperfect, and to some extent erroneous; as "N. E. D." has probably himself ascertained in endeavouring to apply his theory to the phenomena of the "terra-voltaic" couple. One or two observations on our part will doubtless enable "N. E. D." to modify his views in accordance with the received explanations furnished by the researches of Ohm and others. In the first place, he ignores the effect of the electro-motive force, due to chemical action, which is active at the surface of contact of the zinc and fluid—maintaining their opposite tensions, and therefore opposing the combination through the fluid of the separated electricities. "N. E. D." attaches, we think, more importance to the action of the negative element in the production of the voltaic effect than is necessary. The negative does not "collect" the electricity produced or separated by chemical action; it merely serves to "conduct" it from the fluid. A plate of pure zinc immersed in water or dilute sulphuric acid, insulated from the earth, becomes acted upon chemically until it arrives at a certain condition of negative tension—say minus 5. When this tension is arrived at the chemical action ceases. The fluid will then have become plus 5. The algebraic difference in the tensions of the zinc and fluid willnow remain constant, whether we connect the zinc or the fluid to earth. If we conduct from the fluid the positive charge, by means of a conducting plate connected with the earth and not liable to chemical action within the battery cell; the zinc assumes a tension —10. If, on the other hand, we connect the zinc to earth, the fluid remaining insulated; the tension of the zinc element becomes *nil*, that of the fluid being +10. In the case of a plate of zinc buried in the earth, the tension of the surrounding fluid becomes practically *nil*; the same condition existing as when the fluid of the battery cell is connected to earth. The zinc plate then assumes a negative tension, say —10; supposing it to be surrounded by the same fluid as that of the battery cell referred to. The effect of establishing a metallic connection between the zinc plate and a negative metal in contact with the earth will probably be now understood.—Ed. E.]

To the Editor of The Electrician.

Sir,—May I be allowed to express my surprise at "Insulator's" short letter which appeared in your last; he seems to labour under a series of delusions with respect to "Scrutator's" article in the Electrician of the 17th January. As far as I can judge I do not think it was written with the intention of attacking "Insulator's" paper which appeared in your 9th number. And as far as "Scrutator" is concerned there cannot be the slightest doubt but that "Insulator's" article will still remain "unattacked."

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Neither can I understand the "unfortunate state" which "Insulator" pities "Scrutator" for having fallen into; is not the boot on the other leg rather? If the name of the commodity referred to be really "*Chatterton's Compound*," where is the "liberty" that has been taken with any one's name? unless, indeed it should be called "Insulator's Compound;" perhaps the two are synonymous. There *may* be another name for the material but I have never heard of it, nor has "Scrutator," I dare say.

The statements which "Scrutator" "regrets having been made to the injury of other manufacturers," "Insulator" may rest assured has no reference whatever to his article, but to the publicity given to the decomposition of certain india rubber covered wires in the Government's Report. I am astonished he should attribute vain motives to "Scrutator" in having assumed such a cognomen, and yet allow the same motives to influence him in donning a cap which was never intended for him to wear.

I should fancy "Scrutator," with all his "vanity," lays no claim to "originality," that indeed is an exceedingly rare article in these "degenerate days."

If the assertions made by "Scrutator" respecting the manipulation of india rubber, its application to the wire, and requisite conditions, be correct (and however unoriginal his article may be, it bears the mark of a practical man, thoroughly conversant with the subject on which he writes, and no theorist upon second or third hand statements), why then his concluding remark, which came in, as it were, by the way that "Insulator was not conversant with the manipulation of the gum in question, is undoubtedly correct, inasmuch as the finishing paragraph of "Insulator's" article, that "In order to utilize the superior insulating properties of india rubber it appears indispensable to apply over it a protecting body, which of itself is incapable of affecting the india rubber, or of being changed by elevation of temperature" is manifestly fallacious, as every body practically acquainted with the manufacture and application of india rubber can testify.

Passion is proverbially blinding. I can only account for the strange misconception of "Insulator's" letter from its having evidently been written in a fit of bad temper. I have too high an opinion of him to think that he could have made such mistakes under any other circumstances; and however we may deplore the discourteous language in which it is phrased, it may well be excused upon the same grounds.

February 3, 1862. AMICUS.

To the Editor of The Electrician.

Sir,—Your correspondent "Scrutator" much regrets having given offence to "Insulator" by giving the name of "Chatterton's" compound. By what other name could it be designated to be understood by the public? —Yours obediently, SCRUTATOR.

February 3, 1862.

To the Editor of The Electrician.

Sir,—On the subject of Smee's batteries, mentioned by a correspondent on page 132, with your permission I should like to remark that if in the arrangement he describes, the water, acid, and mercury are perfectly pure, and the zinc ordinarily good, there will be no fear of the battery deteriorating in any way till the solution is thoroughly exhausted.

In order, however, to obviate the injurious deposition of the sulphate to which you allude, it will only be necessary to observe that the *glass* vessel should be of considerable depth, say 6 or 7 inches below the bottom edge of the plates, which should not be in too close proximity.

In this case, if undisturbed, the whole of the sulphate will descend to the bottom, and there form crystals.

The silver plate should be well platinized, especially on the edges, and care should be taken not to allow any naked or ill-protected copper wire to be exposed below, or even above the solution, as the slightest particle of its sulphate forms the centre of a mischievous and continuous deterioration.

Connection with the zinc is best effected by means of a well wrapped and waxed copper wire, having its extreme end uncovered and immersed in the mercury trough or shoe.

The merit of the above is due to Mr. G. Mathiot, of America, and has been employed by him for all purposes with success, the precautions pointed out being arrived at by him through experience.

He mentions having had the plates immersed for four years, merely adding distilled water from time to time to supply the loss caused by evaporation, but the current in this case was only used intermittently for gilding, &c.—I am, yours respectfully, H. T. (Bath.)

February 3, 1862.

THE CURRENT IN COILED CABLES.

To the Editor of The Electrician.

Sir,—1. I have only a few remarks to make in reference to "J. G. LT.'s" communication on the above subject. Mr. Webb will doubtless reply to that portion which relates to himself personally.

2. It would have been more instructive and interesting if your correspondent had made his experiment without the use of the earth at all, viz.: by connecting M and G to the battery direct. Had he done so, he would have more clearly comprehended the phenomenon.

3. The direction of the deflection of the needle cannot be taken to indicate the passage of a current into, or out of, a cable, because, as that deflection depends upon the position of the poles of the magnet, and the manner in which the wire is wound, it may be one way with one needle, and the opposite way with another. It is, however, always determinate with the same galvanometer, and in "J. G.'s" experiment showed, as described by Mr. Webb, that the coiled current is in the same direction as the primary.

4. If "J. G.'s" explanation of the phenomena be correct, then it should be evident on straight wires, but it can only be produced *visibly* on coiled wires. Hence, "*a priori*," his explanation cannot be correct.

5. If his diagram (p. 154) be correct, on completing contact simultaneously between *a b* and A B, both needles would undoubtedly be deflected by the static charge alone, and in the same direction as the primary currents. This argument, therefore, amounts to nothing.

6. Your correspondent, with 12½ miles of cable at his command, should certainly be able to distinguish the difference between the primary current and static charge, but the following sentence shows a lamentable ignorance of the first principles of lateral induction. "Static charge is the current flowing into a wire until it is filled. Since the "*secondary deflection*, which he terms 'Coil current,' is but a *part* of the primary or static charge, how is it possible, *under any circumstances, for a part to exceed the whole?*" Oh, fie! "J. G. L.T."

7. The primary current, the static change, and the coil current, are three separate and distinct phenomena, and if your correspondent will but take the trouble to read what has appeared in your columns, Professor Thomson's paper in the *Philosophical Magazine*, and Professor Faraday's researches on "Dynamic Induction," he will be saved the necessity of adding himself to the daily increasing list of the would-be neophites in the profession of a TELEGRAPHIST.

To the Editor of The Electrician.

Sir,—Will you inform me of the simplest method of detecting a fault in a line wire laid under ground in iron piping for a distance of 200 or 300 yards?

In Lardner's "Museum of Science," No. 35, page 148, there is a plan shown and described of the electric telegraph. Is that the simplest?

2. Would you describe the simplest way of casting zinc plates and amalgamating them, as a part of the amateur's manipulation?

3. How to repeat Franklin's experiment of drawing lightning from the air by a kite, and Crosse's method by a long suspended wire in a more simple manner than Noad describes it? F. H. SEWELL.

Lindfield, Cuckfield, Jan. 28th, 1862.

THE CURRENT IN COILED CABLES.

To the Editor of The Electrician.

Sir,—I am afraid your correspondent, "J. G. LT.," must support his "reasonable theory" on the cause of what I must still call the "coil current," by rather more reasonable arguments, and by statements more in accordance with facts, and the known laws of electric currents, than he has as yet done, before he will make any converts amongst those who have considered this subject, and have witnessed the effects in question.

A letter on any subject which could be put to the test by any and every one, would soon either be corroborated or denounced by many; moreover, such a one as your correspondent's, containing (from the hands of an anonymous writer) apparently, an easy and obvious solution to a problem which has occupied the attention of our first electricians, and none of whom have been fortunate enough to pitch on "J. G. LT.'s" theory would certainly be received with extreme caution.

The letter might therefore be safely left to find its own level, were it not that those who have the means of making such experiments are few; and consequently, anything containing the details of an experiment, assumes a certain amount of importance, not always warranted by its merits, in the eyes of those who, not being so fortunately situated for experiments on cables, may have to gather their information from the published experiments and deductions of others. It behoves the few who have had the means of making these experiments, therefore, not to allow any erroneous publication on the subject, backed up by experiments, to go unchallenged.

"J. G. LT." has evidently proved to his own satisfaction, that the current in question which is produced at the near (or battery) end of a coiled cable, after breaking contact with the battery and connecting to earth, and which current is in the same direction as the primary current, has nothing to do with the inductive action from coil to coil, but is simply an effect caused by the static charge re-entering the cable at the near end.

This theory is set forth as follows:—

"May not the cable be said to be unequally charged throughout, during those 3 seconds, and the wave, at the moment of breaking the battery circuit, be compared to a wedge, the thin end of which is toward the battery, and the thick end at the other extremity? if so, then, as the two ends are in metallic contact at same terminal screw, and are of unequal tension, would it not be reasonable to suppose that a portion of the current from the thick end of the wedge (pardon the simplicity of my comparison), would flow in at the thin end in order to create an equilibrium of tension throughout its entire length?"

Unfortunately, to suit his theory, "J. G. LT." has rather reversed the order of things, for he compares the unequal state of the charge in a cable at the moment of breaking the battery circuit, to "a wedge, the *thin* end of which is *toward* the battery, and the *thick* end at the *other extremity*."

Now the thick end of the wedge being in reality at the end nearest the battery, when this end is connected to earth or to the other end of the

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cable, if earth connection is at the same time cut off, a current must be produced in the *reverse* direction to the primary current, a current well known as the return current. This current is therefore in the exact reverse direction to the coil current.

By reversing the order of things, "J. G. LT." has assumed therefore at the distant end an accumulation greater than at the near end; and he suggests therefore, that "a portion of the *current* from the thick end of the wedge would flow in at the thin end in order to create an equilibrium of tension throughout its entire length."

"This," he says, "would coincide with the observed phenomenon of a right hand deflection, because it would be a portion of the *primary charge* entering a *second time* into the cable in the same direction as the first," and he further satisfies himself of the perfect coincidence between his theory and practice, by explaining, in a manner which I confess I cannot follow out, the exact action by which the equilibrium is gradually restored at the end of three seconds.

Now, if a portion of the same charge re-entered the cable in the manner described, it would certainly coincide with the phenomenon observed. But, even allowing "J. G. LT.'s" false supposition as to the position of the thick and thin end of the wedge, this alone of itself would not in the least explain, according to any established laws of electric currents, why electricity accumulated in a conductor from one pole of a battery, the other pole of which is connected to earth, should thus pass a point in contact with earth (and consequently in connection with the outer armature) to enter afresh into the same conductor.

"J. G. LT." therefore frames a theory of his own, which is as follows:—

"Moreover, by giving an electric current two routes of equal tension it will be equally divided. Every wire or metal, in its normal state being in contact with the earth, must be of the same electric tension as the earth at that spot (*vide* p. 25). This being taken into consideration, on breaking the battery circuit, we have a cable, containing a wave of electricity moving forward, and leaving the near end of the wire (K) in its normal state, in connection with, and of the same electric tension as, the earth. On the arrival of the wave at the other end of the wire (M) it finds itself in metallic contact with *two* routes of *equal tension;* one the end of the cable K, the other the earth wire, and therefore will divide itself, and escape part into the earth and part into the cable at K, a *second time* giving a *right* deflection; the greatest perpendicular of the wave, on its arrival, causing the maximum deflection, and after that has passed, the wave diminishing in intensity, the second deflection will likewise diminish until it disappears entirely."

Here then the charge is spoken of as a wave, "moving forward and leaving the near end of the wire in its normal state," and this wave on arriving at the point of contact with earth, "finds itself in metallic contact with two routes of *equal tension*, one of the cable, the other the earth wire, and therefore will divide itself, and escape part into the earth, and part into the cable at K," (*i. e.* the near end.)

Electricity is here treated, therefore, as moving bodily forward in a mass, leaving all behind it in a normal state; and coming on two channels, some of it goes into both.

This is certainly a novel view in regard to "electrical currents." It is not even a difference in resistance which causes this splitting of the moving mass of electricity, but simply that there are two routes, both in a normal state, and if therefore, the end of another conductor (insulated or not at the other end) happened to be in contact at the same earth contact as the experimental wire, it ought also (according to "J. G. LT.'s" theory), to become charged, for it would also be a channel under *equal tension*.

In fact, "J. G. LT." has evidently attempted to work into a theory the first crude impression that arises in the mind when first witnessing the coil current, viz., to use Professor Faraday's words, that "electricity circulates with something like *momentum* in the wire."

Unfortunately, besides the slight mistake about the position of the maximum tension at the instant of breaking contact, there are a few well-known facts, which are quite contrary to the theory.

If two separate straight cables looped together at one end, so as to form a single cable, having its two ends available for the same experiment as for the coil current, a current at the battery or near end will take place *reverse* to the primary current, and consequently not the coil current. This, as I have observed, is the current commonly called the "return current."

In such a case, we have all the conditions for "J. G. LT.'s" theory, the static charge can all go out if it likes at the further end, and some of it can re-enter the near end if it likes; but somehow or other, it seems to prefer going *out* at *both* ends, and never attempts to re-enter.

Furthermore, as "J. G. LT." seems to base some of his points on the fact, that, in the experiments described, the two ends are connected together at the earth plate, so as to allow of his wave to divide itself between the earth and the other end of the conductor, which he has so ingeniously cleared of all charge, he will find that if two earth plates are used, and consequently no metallic circuit exists, the coil current is equally observable, provided that the plates are of similar metal, and large enough to prevent polarization currents from interfering with the experiment. In such case, therefore, according to "J. G. LT.'s" theory, the "wave" must dive into earth, and then comes *out again* to enter the near end.

And again when no earth contact at all is used, the coil current may be produced, and will be *exactly contrary* to the current, which would be produced by the thick ends of the *two opposite wedges*, which would now exist, flowing together in the way which would occur if the conditions for the coil *current* did not predominate.

The effects which are produced by the static charge in a conductor stretched out straight (or even looped round so as to have its two ends together), are well known, and in perfect accordance with the effects which should be produced, according to the general laws of electric currents, under the conditions of accumulation which are known to exist. But none of these effects coincide in the least with "the coil current," and furthermore, it is impossible by any means to reconcile the phenomenon of the coil current with any re-distribution of the static charge, unless it be influenced by other conditions than those of a straight conductor uninfluenced by any other charged conductors.

I may here remark, that although I have termed the current in question the coil current, because of its being more powerful in a coiled than in a straight conductor, it is only under these circumstances that it can overpower the effects of the static charge in a submarine wire flowing out at the near end. Professor Faraday, who gives examples of its detection in straight conductors, attributes its *increased* effect to the coiled state, but does not consider the coiled state as an essential condition for its production.

With regard to "J. G. LT.'s" experiments, the directions of the current are not sufficiently indicated by saying the deflections were "similar to the charge," considering the divided state of the circuits in the diagrams. But whatever effect occurred it must have either indicated a coil current or not. If it did indicate a coil current, such current could not be accounted for by some of the thick end of the wedge entering the thin end, any better than in any other case. Since the end A is insulated the charge at the moment of breaking the battery is no longer a wedge, but of equal thickness throughout; when the connections to the two ends are made, if the static charge predominates over the coil current, the static charge will flow from both ends of the cable through the galvanometers to earth, the same as in every other case when the coil current does not predominate. If this effect is not visible, it simply shows that the conditions for producing a coil current have predominated.

With regard to my quotations of authors about the size of the earth as a grand receptacle for electricity, I would remark that if "J. G. LT." reads my essay on the subject, he will perceive that those quotations were made with the express purpose of *controverting that theory*.

"J. G. LT." next quotes my allusion to the surface of the earth connection, which I specified in disputing Professor Wheatstone's views of the cause of these currents. Professor Wheatstone attributed these currents to polarization of the earth plates; now even if two earth plates are used of similar metal, and sufficiently large, no polarization can occur. To show that in my experiments no polarization currents could possibly occur, I specified that not only was there but one connection with the earth but that this was of sufficient surface to prevent polarization, even if *two* such earth plates had been employed. This was perhaps an unnecessary precaution. On this, "J. G. LT." conjures up a little theory for me "about the large surface *absorbing* the electricity, and about the earth, on account of its size, receiving all the electricity."

"J. G. LT." evidently lays great stress, for the purpose of his theory, on the resistance between the earth terminal and the earth, consisting of a few feet of copper wire, but I would remind "J. G." that if such resistance could possibly cause some of the thick end to enter the thin end of the wedge, and thus redistribute the static charge, it would produce a current in the circuit *reverse* in its direction to the coil current.

With regard to "J. G's." definition of *static charge*, viz., that it is the *current* flowing into the wire until it is filled, I must beg to differ from him: the static charge is *an accumulation of electricity*, and not a *current* at all. "J. G." confounds the action of *charging* with the charge itself. It is true that for brevity sometimes we speak of the current produced in charging a wire as the "charge," and the current produced by the static charge flowing out as the "discharge," but that is no reason why the term *charge* is never to be used in its real sense, particularly when it is expressed in full—*static* charge. I must still, therefore, maintain that we may have conditions when the "static charge" may be sufficient, as it flows out of the wire, to overpower and predominate over the coil current.

In the following paragraph "J. G." evidently thinks he has a case of mathematical "*reductio ad absurdam*."

"Since the secondary deflection, which he terms 'coil current,' is but a *part* of the primary or static charge, how is it possible, *under any circumstances, for a part to exceed the whole.*"

"J. G." forgets one little thing, and that is, that as I *don't in the least* allow that the coil current *is* a part of the static charge, I did not quite frame my statements to dove-tail into his theory.

The next paragraph, relating to my experiment on 70 miles of wire, contains a query as to the possibility of a coil current or any induction current taking place in what may be termed, in fact, a huge induction coil, because it only contains "*one metal?*" and "J. G." then suggests his own theory, of a long wave of electricity running out at the distant and into the near end, &c., as before, which would be *quite irrespective of any inductive action between the convolutions of the coiled conductor.*

I should recommend "J. G." to study a little the question of the "coil current" a little further, before he attempts to propound another theory on the subject.

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Let him make a few experiments to ascertain how far he can obtain the coil current when a cable is *not coiled*, but under favourable conditions for the static charge, and afterwards a similar experiment on a coiled wire without any outer armature, and in which consequently the ordinary static charge will be weak; and he will perhaps then arrive at views rather different to the hasty theory he has advanced, in opposition to those, amongst whom is one at least of our first electricians, who have made rather more investigations on the subject than "J. G. LT.," and even now make no further theory than that the current is one occurring in a straight conductor, but increased in a coiled one, and consequently, only visible in opposition to the discharge of the static charge, in the case of a submarine cable, when the cable is *coiled*. F. C. Webb.

To the Editor of The Electrician.

Sir,—In the Government Telegraph Report, p. 338, the following is given, by Dr. Miller, as the composition of a piece of ordinary good commercial gutta percha:—

Pure gutta...	79·70
Soft resin	15·10
Vegetable fibre	2·18
Moisture	2·50
Ash	0·52

Although somewhat of a chemist myself, I am greatly puzzled with respect to the last constituent in this statement of the analysis. If the ash proceeds from the calcination of the other constituents of the gum, then it is weighed twice over; and the analysis, in spite of the semblance of extreme accuracy implied by the two decimal figures, is obviously faulty. If simply an impurity of the gum, the indication of its probable source would be of interest to those who, like myself, are studying the chemical characters of this material and other substances of similar nature. Perhaps some of your readers can afford me the information I require.

M. F. (Manchester).

DR. HAMEL'S ACCOUNT OF SOEMMERRING'S TELEGRAPH.

Sir,—It afforded me extreme pleasure to read in your last number the valuable and most interesting paper by Dr. Hamel. The history of the origin and progress of an invention of so much importance to mankind has long been wanted. The merit of having been the first to apply electricity for the purpose of the transmission of thought has been claimed by several philosophers and others. Dr. Hamel's well known indefatigability in the pursuit of historical facts is a guarantee that we shall soon be in possession of a true and full account of the first introduction of this wonderful discovery into England.—Yours, &c., Historian.

Miscellanea.

Oddity of the English.—The following anecdote, illustrative of the "oddity of the English," is now going the round of the papers at Naples. When the telegraph was first opened to Newfoundland, Lord P., a distinguished member of the senate, came to the office and said he wished to send a message. "The line is not yet open to the public, my lord." "But you know me; I have 20,000 'actions' (shares) in your line, and I will give £200 sterling for a message and answer." "Your lordship must wait two hours for a reply." The message was:—"*Send me the strongest possible electric spark.*" Lord P. waited till he heard as follows:—"*In one minute the spark.*" His lordship then applied his cigar to the wire, and walked off contentedly, with a light which cost him 5,000fr. The story is seriously repeated from paper to paper, and is generally believed "without a struggle."

A well known French inventor, M. Ador, who died some years since at Paris, conceived the idea of applying the system of atmospheric pressure to the transmission of written messages to a considerable distance through a tube of small diameter. Some experiments made at the Gardens of the Tuilleries were attended with considerable success; a rapidity of 300 *mètres* per second being attained. The system appears, however, to have been first proposed by a Danish engineer. M. Medhurst, who, in 1810, described an arrangement very similar to that now in operation between the stations in London of the Electric and International Telegraph Company, and at Battersea. The idea was probably suggested by the writings of Dennis Papin.

The Atlantic Telegraph Revived.—There is reason to believe that attempts will shortly be made to connect England and America once more by the electric telegraph, and this time with greatly increased prospects of permanent success. Recent occurrences have impressed the Governments of England and of the United States with the enormous importance of such a means of communication, and it is not too much to say that, had an electric telegraph existed between the two Continents, the affair of the Trent would not have been attended with those serious apprehensions which we have witnessed; would have saved the vast expenditure which our Government incurred; would have prevented the depreciation of property in both countries to the amount of millions, and that interference with commerce and manufactures which resulted from the ill-judged and unauthorised conduct of Captain Wilkes. The President and Government of the United States are so fully sensible of the importance and value of telegraphic communication, and of the possibility of providing it, that they have decided upon giving every support in their power to any well-considered project of that kind. The Government of the United States have in the most liberal manner offered to subscribe one-half of the sum which would be required for making the cable, and give the use of vessels of their navy in assisting to lay it, provided the British Government will grant the remaining portion of the sum. Mr. Cyrus Field, who took so active a part in reference to the former Atlantic telegraph, has, we are informed, undertaken a mission to this country, for the purpose of inducing the British Goverment to act in a spirit of equal liberality, and co-operating with this friendly offer on the part of the United States. As further evidence of the friendly spirit which has actuated this offer, the Government of the United States are perfectly content that the telegraph should have its terminus on British territory, as that will afford the nearest point of communication with England or Ireland. Any arrangements that would be entered into between the two Governments would, of course, provide for the efficient working and use of the line, and would guarantee its protection by both countries in the event of hostilities. We are at a loss to see upon what grounds our Government can refuse to respond favourably to the offer, which, if not already made, will shortly be submitted to its consideration. The cost of the cable, calculated with the greatest amount of care, and with every improvement, would not be greater than that which was expended on the line from Malta to Alexandria, and which was wholly defrayed by the Government. Our interests with the American continent are not less important than those with India: and, even if greater importance were to be attached to our Eastern possessions, it would only render still more necessary a line across the Atlantic, seeing that, with the telegraphs which already exist on the American continent, and which now extend to the Pacific coast, it would afford a means of rapid and valuable communication from the West with China and our Indian empire.

The Cork journals of Saturday mention that from 100 to 200 workmen are already engaged upon the various parts of the Irish lines of the London and South of Ireland Direct Telegraph Company. It will further interest our readers to learn that Lord Fermoy, chairman of the company, when applying to the Cork Corporation on Friday, for permission to carry the Company's wires into the city of Cork over the houses, which permission he obtained, reported that Mr. Reuter had already instructed his agents in America to address his despatches to Roche's Point; that in a fortnight the lines from thence to Cork would be complete, and thus the Cork people would have their American news an hour and a half earlier than at present. Of course this advantage will extend to England, and the company have done wisely to give the public the benefit of their exclusive concession of Roche's Point at the earliest possible moment.

Light and Colour.—When sunlight falls on a body, a portion of up *white* light is reflected from the surface of the body—A second portion is reflected after it has entered the body to a greater or less depth—It is this latter portion which gives the body its colour—Different bodies have the power of absorbing, or quenching within them, different kinds of light—A red body is red because it has the power of quenching all rays except those which compose its red. A blue body is blue because it has the power of quenching all rays except those which compose its blue—Brilliant crimson feathers, for example, if illuminated by pure blue light, are as black as those of a raven;—conversely, a pure blue would be black if illuminated by red light—When the human face is illuminated by a flame which contains no red rays, the lips and cheeks lose all their redness; in the same light red and crimson flowers lose their bloom—In fact, the colours of bodies are entirely due to the light which falls upon them. If the white light of the sun were simple instead of compound, we should have only light and shade in the world; but we should have no colour. A metal heated to whiteness gives a *continuous spectrum* as long as the metal remains in the solid or liquid condition—But when a metal has been reduced to vapour, and when that vapour is rendered luminous by intense heat, the spectrum of the vapour is usually composed of brilliant bands—Every metal has its own distinct system of bands—When metals are mixed together so as to form alloys, the bands of each metal are produced in the spectrum of the alloy—Thus, knowing the bands that each separate metal produces, we can determine from the spectrum of an alloy the metals of which it is composed—The bands of the metal also exhibit themselves when the salts of the metal are raised to a sufficiently intense temperature. A luminous vapour absorbs those rays which it can itself emit—Thus the light of incandescent sodium vapour is intensely yellow; but when a beam from the electric lamp is sent through this vapour, the yellow rays of the electric light are intercepted—The sun is supposed to be composed of a solid or liquid central portion, which of itself would give a continuous spectrum—But this nucleus is surrounded by a flaming atmosphere, through which the rays from the nucleus have to pass—This solar atmosphere, or photosphere, as it is often called, intercepts those rays of the nucleus which it can itself emit, and hence the solar spectrum is always furrowed by dark lines (*Frauenhofer's lines*)—From these lines we can determine the metals which produce them; and in this way it has been found that many of the terrestrial metals are present in the sun.

To Correspondents.

A Student.—We will obtain the practical information you require.

*** In consequence of the press of matter, several articles are left over until next week.

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The Electrician.

Vol. I. No. 15.—February 14, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

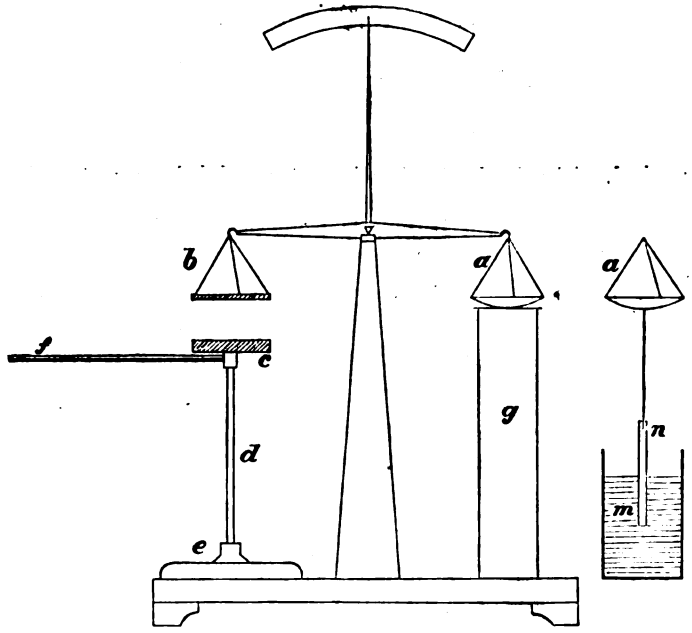
[Continued from p. 158.]

29. In producing the machine, we used materials of different kinds; the appropriateness of which had been suggested by the practical experience of former observers, and of which we shall still have to avail ourselves for the construction of the instruments we are about to describe. In our own experiments we saw that electricity is not passed with equal facility by all kinds of matter; for we used glass to confine it, and metals to conduct it; and it is quite obvious that we employed atmospheric air also to cut off communication between the metals and other things, or, as electricians say, to insulate them; and had the air possessed the same conducting power that we find in metals, electricity, as a science, would probably have remained for ever unknown. The student should, therefore, now be informed that if all the substances in nature were to be arranged into a list according to their capabilities of conducting electricity, we should have a graduated series, beginning with the metals as the best, and terminating with resinous substances, and the gases generally, as the worst conductors. It may suffice for all practical purposes if we give here the following summary:—Metals, charcoal, plumbago, water containing saline matters, water in a fluid state, or contained in organic, mineral, or æriform substances; porcelain, dry vegetable and animal matters, wool, silk, mica, glass, sulphur, amber, shellac, resins, dry air, and other gases.

30. It will be observed that towards the middle of the list are comprised water, and substances that seem to owe their conducting power almost altogether to its presence in them; and so general is this influence of water, that even the bodies at the foot of the list, which are sometimes termed insulators, are made more or less conducting by moisture deposited upon them from the atmosphere, or naturally existing within them in some minute proportion. The presence of water hygrometrically in the atmosphere is so detrimental to insulation, that, except in very cold weather, when it freezes and precipitates, or on sunny days, when it becomes more assimilated to the gases, it is needful to get rid of it as perfectly as may be by artificial means; such as heating, by a stove, the atmosphere of the apartment in which the experiments are made; or raising the temperature of the insulators, as in the case of the electrical machine we have described; or, otherwise, by holding near to them for a few minutes immediately before they are used, a small piece of heated iron. Silk, glass, and some other insulators, may in great measure be protected from moisture by being varnished, while they are warm, with a heated solution of shellac, or sealing-wax, in spirits of wine, or what is better, absolute alcohol. After all we can do, it must still be taken as a rule that delicate experiments in statical electricity will not afford reliable results in all states of the weather, and but seldom,—except with the utmost possible attention to the cleanliness, dryness, and temperature of the glass, and other insulations; which, indeed, will always need much of the electrician's care.

31. Among the apparatus we shall need is an instrument of paramount importance for measuring different amounts of electrical attraction. Fig. 1 exhibits one of a simple and complete

Fig. 1.



kind, combining all that is really needful in Harris's hydrostatic and scale-beam electrometers. It may be thus described:—A light steel balance about 12 inches in length is so adjusted as to rest in any position in which it may be placed, with its knife edges in notches in two small pieces of flat brass fixed into the top of a tall vertical support made of wood, and so cut away between the pieces of brass as to allow the balance freedom of play. One end of it carries a scale, *a*, and the other, in scale-fashion, a light disc of wood, *b*, about three inches diameter, covered with tin-foil, both suspended by short metallic threads. A second similar disc, *c*, mounted horizontally on a stem of varnished glass, *d*, with a heavy moveable foot, *e*, is placed under the suspended one, and about two inches distant when the balance is in the horizontal position. From below the under side of the lower disc a small brass wire, *f*, coated with sealing-wax to near its end, extends outward, horizontally, for about eight inches; serving to bring the disc, *c*, into metallic communication with any insulated body whose force of electrical attraction upon the disc, *b*, is to be measured by means of counterposing weights at the opposite end of the balance. A tall, loose pillar of wood, *g*, may be placed occasionally under the scale for it to rest upon; and at other times there may be substituted for the block a vessel, *m*, containing water, destined to receive a small cylinder of wood, *n*, fixed temporarily under the centre of the scale, and made to plunge for an inch or two of its length into the water in *m*. For elevating the under disc, and bringing it within given distances of its fellow, it has introduced as occasion may require between its foot and the board on which the whole stands, pieces of plate-glass of known thickness; and, lastly, an arc, *h*, graduated with small equal divisions, is raised above the index, *i*, (which should be a long and straight grass-seedling,) by a stem rising from the central support of the beam, and which, for sake of distinctness, is omitted from the figure.

32. Another instrument required is a discharging electrometer (fig. 2), which may be made by fitting to a large and short cylindrical lamp-glass 7 in. by 3 in., two caps, each turned out of a piece of wood thick enough to leave a solid truncated cone projecting from its inner face, and passing through the centre of each cap and cone, before cementing the wood to the glass, a stout brass wire with a half-inch brass ball on its inner end; one

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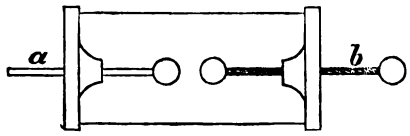
of the wires, *a*, being a fixture, and the other, *b*, travelling backward and forwards through the wood by means of a thread cut upon it, and of an outer ball with a hole through it for receiving a wire by which it may be turned, and its position accurately

Fig. 2.



marked. The fixed wire has its outer end left as a stem for entering the holes of the balls of the machine, and being in a line with its fellow it is easy to bring the inner balls into contact with one another, or to place them any given number of turns of the screw apart.

33. The student will find it very convenient to have three other small holes drilled in the outer ball of his discharging electrometer to receive the ends of wires for connecting it to other apparatus; such, for instance, as the coated jar about to be described, the ball on its stem also being similarly perforated; the same remark applies generally to all the external terminal balls of electrical instruments that need occasionally to be put into metallic communication with one another. He should keep for the latter purpose a few straight pointed wires of different lengths, coated nearly to their ends with sealing-wax; and if some of them, uncoated, be joined in pairs by an intermediate brass tube into which they may partially slide, he will be saved much tedious adjustment of distances. For long communications he will find small copper wires covered with gutta percha preferable to naked conductors; and when he wishes to transmit without loss the whole of the electricity he is dealing with, he should avoid the use of chains, and, as far as possible, other jointed conductors.

34. A *coated jar* is also requisite. This is simply a bottle of thin glass with a wide mouth, and a coating of tin-foil, inside and out, to within three inches of its top edge. The ordinary jars used by confectioners offer the most convenient form of vessel, but unless of modern manufacture they will often be found too thick to be very efficacious. The jar may be furnished with a wooden stem rising out of it five or six inches, and fixed into a block cemented to its bottom, all the wooden parts being covered with tin-foil, so as to place the inner coating in metallic communication with a brass ball by which the stem is surmounted. The uncoated part of the jar should be varnished while clean and warm with a hot solution of shellac in spirit of wine. The jar, for the purpose we are about to employ it, should expose about two square feet of external coating; but others of different sizes may be kept in readiness. In handling this piece of apparatus care should be taken to avoid bringing any part of the person in conducting communication with its inner coating, or painful *electrical shocks* may be experienced. It may be safely discharged by placing a curved wire, held by an insulating handle of glass, or baked wood well varnished, with one of its ends against the ball of the jar, while its other end touches its outer coating, the ends of the wire being terminated by brass balls. Such a wire is known as a *discharging rod*.

35. Provide three *moveable insulated conductors*, all precisely alike, each being a ball five inches diameter, turned as spherical as possible out of pine, and mounted upon a varnished stem of glass 9 or 10 inches long, having its lower end fixed into a wooden foot rather under five inches in diameter. The balls should be covered with tin-foil pasted on in segments.

36. These pieces of apparatus should all be carefully made, as the service they have to perform is of the greatest importance; with them we shall be able to advance our theory considerably, in the first place ascertaining the law of force with which, at a constant distance, electricity and common matter reciprocally attract one another.

Exp. 9. The machine being upon the end of a long and firm table, insert into one of the holes of its positive conductor the stem of the discharging electrometer (fig. 2), with its interior balls from a quarter to half an inch apart. Connect its outer ball, *b*, by a short coated wire, with the brass ball of the coated jar (34), which should stand upon the table and have its external tin-foil in metallic communication with the negative conductor of the machine. Place one of the moveable insulated conductors (35) about 18 inches from the jar; connect it with the ball of the jar on one side by a coated wire, and on the other side make it touch the naked end of the horizontal wire, *f*, projecting from the moveable disc under the balance electrometer; that disc having been previously raised to within about half an inch of its fellow, while the scale, *a*, rests upon the wooden block, *g*, and the balance is in the horizontal position with its index at zero. The two arms of the balance, with their respective loads, having been made to counterpoise each other with accuracy, put an additional weight of a few grains into the scale, and turn the winch of the machine. Electricity will pass from the positive conductor, and discharge itself by a succession of sparks upon the inner coating of the jar, and all the conductors in communication with it, thereby giving them a plus charge, the total quantity of which is appreciable by the number of sparks or discharges that pass between the balls of the electrometer. After a certain number of sparks have been counted the plus electricity acting from the under disc, *c*, of the balance electrometer upon the common matter of the upper disc, *b*, will be great enough in quantity to have an attractive force sufficient to cause the latter to descend, overcoming the resistance of the counterpoising weights placed in the scale, *a*, and it will be found, on repeating the experiment any number of times, all the arrangements remaining unaltered, that the same number of sparks, or very nearly so, will be uniformly effective in raising the same weight. Let the student make himself sufficiently *au fait* with his apparatus to assure himself of that fact, and on the next occasion we will proceed with him to apply it.

(To be continued.)

POSITIVE AND NEGATIVE "CURRENTS."

The fact of there being two theories in explanation of electrical phenomena, neither of which has yet gained universal acceptance among telegraphists, tends in some cases to occasion a confusion of terms in a subject which is somewhat recondite, and which, therefore, needs the greatest accuracy of expression to enable its votaries to arrive at a definite and comprehensible system. It may be said that while these two theories jointly prevail, it is impossible to avoid a diversity of opinion and of terms. But, on behalf of those who are at present following the study of applied electricity, and to whom its future progress and extension may be due, it is to be desired that the technical terms of electro-telegraphy may be so framed as not to involve a confusion of two theories; or, better still, that these terms may be based upon the theory which is found to be most in accordance with phenomena, which may now be observed upon a large scale, as well as in the laboratory. Thus the art of telegraphy, and the science of applied electricity, might profit by the universal application of the theory which they contribute to establish.

The terms *positive* and *negative*, applied to "currents" of electricity, are a frequent source of difficulty and confusion to the electrical student whose theoretical views may be somewhat unsettled. While adhering to the single fluid theory, by which the action of the battery is generally explained, he is liable to confound the existence of two different electrical tensions in the conductor forming the voltaic circuit with the idea suggested by the terms referred to, of two distinct currents traversing this conductor from each end of the battery. He may be told, that whichever theory of electricity we may adopt, the terms *positive* and *negative* currents will be found equally convenient and expressive;

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but it will be long before he can abstract his ideas from the significance of the words, and admit on equal grounds the two contrary hypotheses.

But expressions which may be employed in lieu of these terms by those who recognize the single fluid theory, are not only far more in accordance with observed facts, but are easily comprehensible to those whose views are based upon the opposite theory. Even on the latter ground alone their general adoption would be desirable. "To reverse the direction of the current," or "to send alternate currents in reverse directions" *along the wire*, are expressions which are not liable to misinterpretation, if the words we have italicised are expressed or understood. * The expressions, "zinc to wire and copper to earth," and *vice versâ*, are sometimes preferred by practical telegraphists as being altogether independent of theory; though, in the case of what is termed a "complete metallic circuit," they would be inapplicable. Holding the single fluid theory, we would, for our part, specify the current in the case of an ordinary telegraph line as "direct" to the line, when the latter is connected with the positive pole of the battery, and as "reverse," when the line is in a condition of negative tension, and the current traverses the earth portion of the circuit before arriving at the line wire.

The direction of a current, in accordance with the single fluid theory, is all we require in practice to determine, in order to produce any desired effect, such as the deflection of the galvanometer needle, the polarization of an electro-magnet, or the oxidation of a "fault" in a submarine wire. Conversely, the direction of a given current is readily ascertained by the action of this current upon a galvanometer or electro-magnet. Let us now revert to the terms, *positive* and *negative*, applied to the voltaic current. We find that they refer to the electro-statical condition of certain portions of the conductor; but that the distinctions are practically valueless, unless the direction of the current be specified or understood. Given a voltaic current traversing a certain portion of wire, we may ascertain by means of the electrometer whether electro-statical condition of the wire, or the tension of the current, at this point, be positive or negative. But this information is of itself useless. It neither tells us the direction in which the current would influence the magnetic needle or the electro-magnet, nor the relative positions of the anode and cathode, if the wire were severed and immersed in an electrolyte —points which are alone determined by the direction of current. Supposing the direction of the current, instead of the nature of its tension at this point of the circuit, to be ascertained, it would be impossible from this information to ascertain whether the current was "positive" or "negative." It might be a "positive" in one direction, or a "negative" in the other direction;" and in either case the action of the current would practically remain the same.

On the other hand, when we are told to "transmit a positive current," the expression is equivocal, unless the direction of the current, as well as the nature of its tension, be specified. It may be answered, that the direction of the positive current in the wire, whether transmitted or received, is always in practice understood. In other words, it is understood that the current is to be sent in a certain direction, in which case it appears superfluous to specify the nature of the tension. But when we send a current "direct" to the wire, or a "positive" current, and subsequently connect the line to earth through a galvanometer, we may obtain a deviation of the needle in either direction. This deviation would indicate the *direction* of the current, whether one of discharge or of induction, without shewing the statical condition of the wire. The question is—how could these currents, or any "accidental current," be specified as either *positive* or *negative*; and, supposing these terms to be employed, what would be their significance? The condition we require to know in regard to any current is its direction. To express this important distinction, the terms "positive" and "negative" are obviously, in many cases, useless.

It cannot, we think, be denied that these terms, as applied to the voltaic *current*, might be advantageously dispensed with; although, when for the sake of convenience a term has been coined to express technically a certain action, the practical telegraphist, who is initiated in the true extent of its signification, may often have much to say, "on behalf of this same Falstaff." In this case, however, we have expressions equally convenient in practice, applicable in every case, and which are not liable to lead to confusion or error.

* "One of the self-taught" states, that for a long time he was under the impression that a current along the wire could be alternately obtained from copper to zinc, and from zinc to copper.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 163.]

If we consider carefully every case of accumulation that occurs in practice, we shall find that they resemble in the main points one or other of the various classes of action I have endeavoured to describe, and we can in all cases trace some general conditions which appear to be necessary for electrical accumulation, and which may, perhaps, be summed up as follows:—

Whenever electricity is generated at a source and accumulated on the conducting surfaces connected to the two sides of that source, there exists of necessity, as it were, a chain extending from one of these primary conducting surfaces round to the other, which chain consists in some cases simply of dielectric, and in others is composed of a dielectric, separasing one of the primarg conducting surfaces from a conducting surface, in conductive connection with another conducting surface, which, again, is separated from another conducting surface, and so on until the other prime conducting surface forms one of these surfaces in the chain, when the chain is complete.

Thus in figure 2 (page 122) the primary surfaces connected to the two sides of the source on the surface of A and the surface O F E, and these are only separated by dielectric. In fig. 14 (page 162), the primary surface A, in connection with one side of the source, is separated by dielectric from the conducting surface, G H I, which is in conductive connection with the surface, E F G, which is again separated by a dielectric from the surface of B, and this is in connection with the other side of the source.

In this chain, if considered in any of its simplest forms, such as those shown in figures 4, 13, 14, 15, there exists on each of the sets of opposing surfaces equal quantities of opposite electricity, thus constituting a continued series of forces, alternately of opposite nature, extending from one side of the source round to the other side, at which points of departure and arrival the *equal* and *opposite forces* originating the whole action exist, and thus the whole chain constitutes a perfect *equilibrium*.

This chain it will be found exists in every case of accumulation, and is as necessary for that accumulation as a continuous chain of conductive matter joining the two sides of the source, and termed the *conductive circuit*, is necessary for permanent conduction. I shall, therefore, term it the *inductive circuit*.

This *inductive circuit* not only must exist in every case of accumulation and excitation, but on its actual constitution depends the degree of accumulation which can be obtained with a given source of generation.

It will be perceived also, that in all cases the inductive action is carried on through innumerable paths which, in some cases, are not all equal in length through the dielectric, and that in others the paths do not even all pass through the same number of stratums of dielectric and conducting matter. Thus, in figure 20, let A and B represent two conductors joined to the two poles of a source, and surrounded by a surface L D C K. Then one of these inductive paths can be traced thus: P A B N, and another

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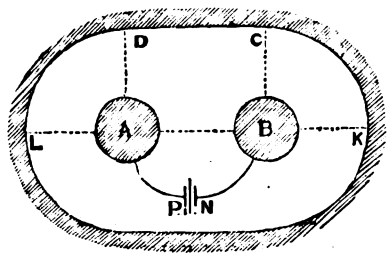
P A D C B N, and another P A L K B N. The former passes only across one stratum of dielectric, whilst the others pass through two. It will be seen that an infinite number of such

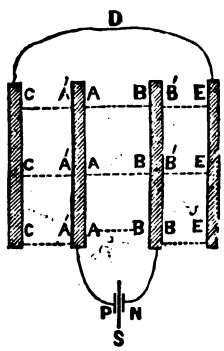
Fig. 20.



paths must exist, and that any single point in one of the conducting surfaces can only be situated in one such path. Indeed, these paths may, strictly speaking, be each considered as separate inductive circuits, forming elements of the whole circuit.

In some cases a large area of the surface of two conductors attached to a source may have each point of that area situated in inductive paths which are all nearly similar; whilst the points in another portion of each conductor may be situated in paths still similar to one another, but so distinct in their direction, length, &c. from those of the former portions, that the whole inductive action may be said to take place in, and be composed of, two branch circuits similar to a branch or divided circuit in the conductive circuit. Thus, if in fig. 21, A and B are two flat

Fig. 21.

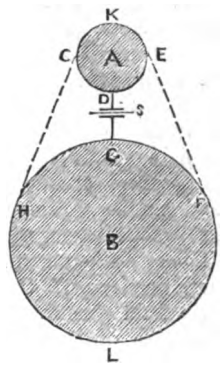


conducting plates parallel to one another, attached to two poles of a source S, and opposite the outer side of these plates are situated two other flat plates, C D E, connected by a conductor C D E. Then, if these are situated far from all other surrounding conductors, the inductive action will practically take place entirely between these plates in the following manner:—One branch of the inductive circuit can be traced from P to the surface A A A, and thence across the dielectric to the surface B B B, and thence to N. The other branch can be traced from P to the surface A′ A′ A′, thence across the dielectric to the surface C C C, which is in conductive connection with the surface E E E, from whence the inductive circuit is continued across the dielectric to the surface B′ B′ B′, and thence to the N pole of the source.

Every portion of surface on which electrical accumulation occurs forms part in an inductive circuit, which circuit is necessary for such accumulation to take place; but it does not follow that every part of the surface of a conductor—some portion of which is electrically charged—should form part of an inductive circuit; or, in other words, it does not follow that because one part of the surface of a conductor forms part in an inductive circuit, and thus becomes charged, that every other part of that surface should also.

Thus, if A and B (fig. 22) be two conductors connected to the two sides of a source S, then the parts, C D E and F G H, are opposed to one another, and form part of an inductive circuit which will allow of accumulation on those surfaces; but if we suppose no further conditions, and consequently no other conducting surface opposed to them in any direction, no accumula-

Fig. 22.



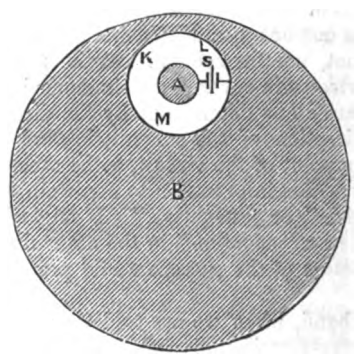
tion could take place on the surfaces C K E and H L F (which do not, therefore, form part of the inductive circuit), except we suppose the action to be carried on in curved lines through the dielectric—a position we shall discuss further on.

This case, therefore, would represent theoretically the case of a conductor charged in the open air from one side of a source, the other side of which was connected to the earth, provided the air was a perfect dielectric, and that the inductive action could not be carried on in curved lines through the dielectric.

The amount of the earth's surface which could become charged would depend on the height of the conductor A above it, and on the size of A. But as long as A was smaller than B, A could never become charged on so much as half its surface.

If we suppose one conductor, A (fig. 23), within the other, B, but separated from it by a stratum of dielectric, we obtain two conducting surfaces, every part of the one of which is opposed to some part of the other.

Fig. 23.



Now, on the surface of the interior conductor A resides all the electricity generated from that side of the source S to which it is connected, and it follows from what has already been advanced, that the equal quantity of electricity of opposite name generated is all resident on the interior surface K L M of the conductor B, and none on the exterior of B. Thus every portion of the surface of the conductor A is comprised in the inductive circuit, and every portion of the interior surface of B is also in the inductive circuit, but the exterior surface of B is not in the circuit. This case would represent, therefore, the case of a conductor within a cavity in the earth, or, in fact, within a room, charged from a source, one side of which was connected to the earth, which is represented by B, and the exterior surface of which does not become charged or affected in any way. The *surface* of the earth here implies the outer boundary of the earth, and all conducting matter in conductive connection with the earth, whether artificial or natural.

The conditions necessary for every part of the exterior surfaces

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of two conductors, exterior to one another, to form part of an inductive circuit, and thus become charged on *every* part of their surfaces obtain in many complicated forms, some of which are illustrated in figures 14 to 19; but one condition seems absolutely necessary, *viz.*, that at some distance they be surrounded in every direction by a common conducting surface, or else each be surrounded by conducting surfaces in conductive connection with one another.

It does not seem absolutely necessary, to the *general* conditions for accumulation, that the two surfaces connected to the sides of a source be opposed directly to one another in *every* direction, or indirectly, through the intermediate agency of other conducting surfaces; but unless these conditions for an inductive circuit passing through *every* point in the surfaces be fulfilled, accumulation cannot occur on *all* parts of those surfaces.

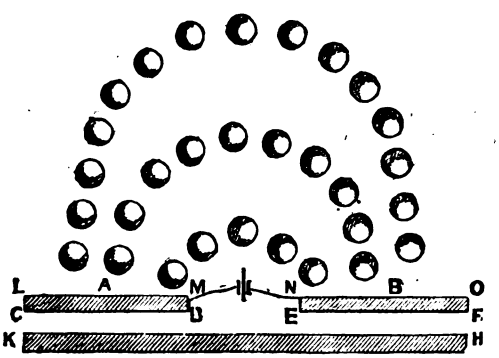
I shall suggest, however, further on, how, in every case of charging a conductor that can occur on this earth, and in our atmosphere, it seems probable that such conditions for an inductive circuit in every direction are always fulfilled, whilst in all cases that occur in ordinary experiments these conditions nearly invariably obtain.

I have shewn (fig. 22) an example of two conductors, connected to the two sides of a source, having no outer opposing surface and having only a portion of their surfaces opposed to one another, and consequently only those portions charged.

We may suppose another case where two conductors have certain parts of their surface, neither opposed to one another or to any intermediate conductor, whilst a portion of each surface is opposed to a common or intermediate conducting surface.

For instance (fig. 24), if A and B represent two conductors

Fig. 24.



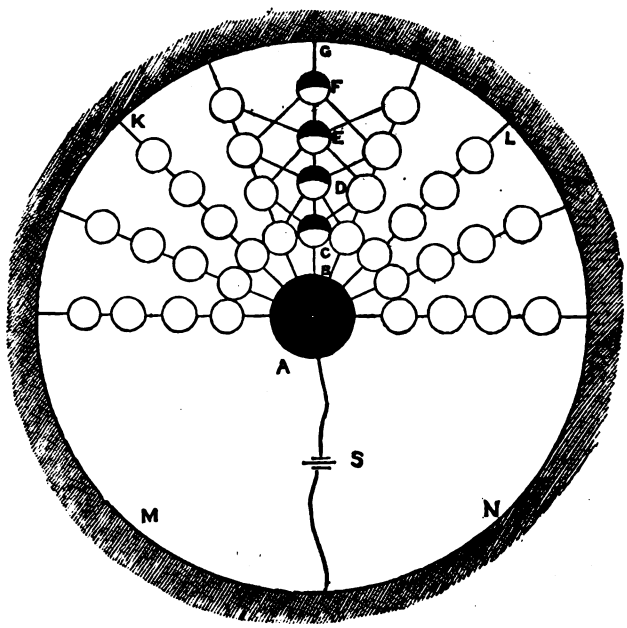
attached to a source, then the surface C D and E F being opposed to the common surface K H, accumulation could take place on those surfaces even if the whole arrangement were entirely surrounded by a dielectric of absolute insulating properties, and extending in every direction to an infinite distance.

In such case, however, there would be no conducting surface opposed to the upper sides L M and N O of A and B, and it would, therefore, seem doubtful whether these surfaces could become charged at all.

If we suppose that each particle of a dielectric can by acting on its contiguous particles, not only in one, but in every direction, carry on the action in curved lines, it seems, at first sight, possible to imagine a chain of polarized particles extending from one surface, L N, to the other, N O, as represented by the small circles in fig. 24, which would thus form an induction circuit, and consequently allow of a certain accumulation on these upper sides of A and B, although that accumulation would be of very much less density to that on the lower sides C B and E F. That inductive action does actually take place in curved lines, in certain cases, Professor Faraday has demonstrated; but, in the case of Professor Faraday's experiment, since it was performed in a room, and thus surrounded completely by a conducting surface, the case is not in the least similar to the one I have here suggested. For, since in a room an outer opposing surface exists, if any single surface, whether conductor or non-conductor inside is charged, it can only be so charged by a corresponding charge on the outer opposing surface. We obtain, therefore, two boundaries (*viz.*, the outer surface of the charged body, and the inner surface of the room), on which equal and opposite forces reside. Whatever direction, therefore, the lines of polarization may be forced to take to form equilibrium, they always terminate on some part of the outer conducting surface, and are thus met by an exactly equal and opposite force.

For example, if A (fig. 25) represents a charged sphere sur-

Fig. 25.



rounded by a conducting surface K L N M. Suppose the sphere A charged by a source, one side of which is connected to the outer opposing surface, and suppose the small circles to represent small insulated conductors representing again the particles of the dielectric. It is evident the resultant of all the forces tending to polarize any line of particles, C D E F, extending between any point B on the surface of A, and the nearest point G of K L N M, will produce such a distribution of the electricity on these particles, that a line passing through their point of maximum positive density, and maximum negative density (or what may be termed their axis of polarization), will lay in one and the same straight line between B and C, this line, on which are alternately situated opposite forces, is, therefore, met by equal and opposite forces at its termination on the two boundaries, which forces are, indeed, the cause of the polar state of the particles. All is, therefore, in equilibrium, and no polarization or action can exist beyond these boundaries.

If we consider a somewhat similar case, with this difference—that between the sphere A and the outer conducting surface E G K, be interposed a conductor, A B C, in connection with the outer opposing surface (as in fig. 26), it seems perfectly possible to conceive such a state of polarization of the particles, that the resultant of the forces tending to polarize some of the series of particles will no longer lay in straight lines between the two boundaries, but will form curved lines; and yet, that such a distribution of the electricity on the two conducting surfaces shall take place that these curved lines of polarization, which *must* all terminate on the two charged surfaces, shall meet with an exactly equal and opposite force to that existing at the extremes of the lines themselves. This distribution of the electricity being just as much the result of the altered conditions we have supposed, as the alteration in the direction of the lines of polarized particles.

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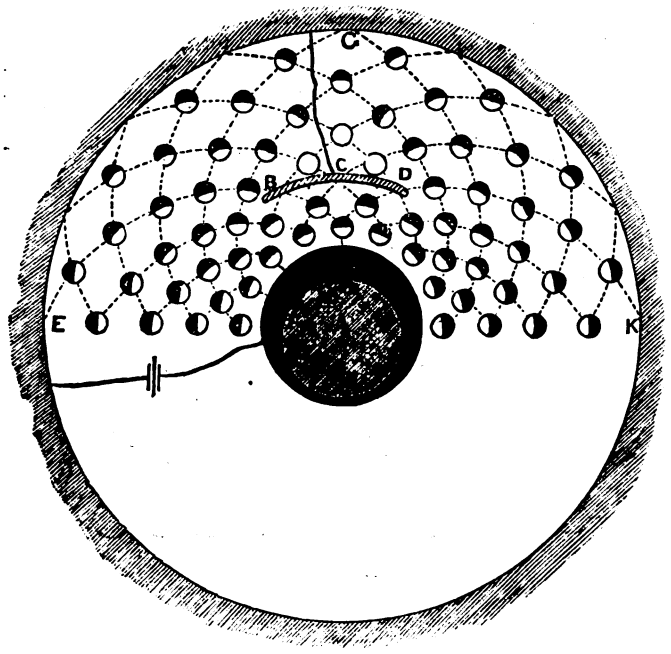
We still have in such case, therefore, equilibrium, and a boundary to the whole action.

If, however, we suppose that the polarization of the particles

Fig. 26.



of the dielectric can go on, without any bounding surface, merely from the action between two surfaces laying in the same plane as in fig. 4, then it seems probable that no such equilibrium can exist. For each particle must act to some extent on the one next furthest removed from the conductors, and since each particle, however far distant from the conductors, has still others beyond it (for we are supposing a boundless dielectric), we arrive at a state resembling the radiation of light or heat, which would have no termination.

We should have, in fact, lines of force unterminated by any opposing force, which would render electricity a *radiating* force; whereas, if we consider the action of electricity in all the cases with which we are familiar, we cannot fail to perceive that it has all the essential properties of a *polar force*. It seems doubtful, therefore, whether such action in curved lines would take place in a boundless and perfectly insulating dielectric, or whether, if two spheres were connected to the two sides of a source, the action would not more probably take place simply in straight lines between the two conductors thus charging only half of each of their surfaces.

From this it seems also open to speculation whether, if two conductors connected to the two poles of a source, were separated an infinite distance from one another in a boundless dielectic, they could receive any charge at all.

Indeed, we find invariably that the greater the distance between the surfaces composing the *inductive circuit*, the less is the accumulation with a given source, which would lead us by fair reasoning to suppose that if this distance were infinite no accumulation at all could take place.

Such cases, of course, cannot exist. In all ordinary experiments on static electricity the operations are nearly always carried on within a room, and consequently the surface of a solid conductor envelopes and bounds the whole action.

In the open air, it is true, the only solid conducting surface may be in an extreme case a portion of the surface of the earth, which may practically be considered as an indefinitely extended plane. This even would fulfil of itself, alone, the general conditions I have already mentioned as necessary for accumulation, for I have suggested that a bounding conducting surface around a conductor, and attached to the other pole of the source, is not necessary to fulfil the conditions for accumulation, but that if opposed on one side by another conductor connected to the other side of the source, the conductors can still receive a charge on their opposing sides.

A sphere connected to one side of a source in a perfectly insulating dielectric opposed only by a boundless plane of conducting matter below it, to which the other side of the source is attached, would still allow of accumulation, therefore, on every part of the sphere, except a single point at the top, the lower part having the maximum density of charge. The opposing charge in the plane below having a point of maximum density immediately below the sphere, but rapidly decreasing on the parts more removed from the sphere, yet theoretically never vanishing.

(To be continued.)

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 153.]

A considerable amount of information will be found in the Appendix on the general arrangements which have been adopted for manufacturing and laying submarine cables. The contracts that have been entered into have always necessarily presented considerable difficulties, differing entirely, as they do, from any ordinary contract, in which the work, when completed, can be easily measured, examined, approved, or rejected. If, on the one hand, the contractor is made solely responsible and liable for the protection of the line, and is to furnish a guarantee for his sufficient performance of the contract to make or lay it down, then it becomes a matter of great importance to determine for what period of time such a guarantee should be required. Moreover, if this responsibility is laid on the contractor, it is evident he ought to be subject to little interference from other parties, as any guarantee he may give will evidently be useless if, in carrying out the work, he is simply to obey the orders of others. On the other hand, if the control over the work is kept entirely out of his hands, it is difficult so to arrange the terms of the contract as to give him any important interest in the success of the undertaking, and without such interest it is absolutely impossible, in work of such a character, to ensure that diligent, constant care and attention to every detail which is so essentially necessary to its perfection. Again, the risk attending, more especially, upon laying down submarine cables in deep water, is evident from past experience, and is so great that no contractor can undertake the work without a very large margin for profit, which consideration, while it seriously increases the cost of such an enterprise, does not in practice secure its being properly carried out. The Electric Telegraph Company have preferred leaving the construction of the cable to the contractor, but the manufacture in every detail is under the personal superintendence and direction of their own officers, who are, in fact, responsible for the quality of the workmanship. In such case, no extravagant profit need be paid to the contractor, who incurs but little risk. In the other cases, where the whole matter has been left in the hands of the contractor, who, having only in view the laying down of the cable, which should be protected for a limited length of time, does what he has agreed to do in the most economical manner possible, and without regard to the ultimate durability of his work. All such contracts have been proved to be objectionable, and telegraph companies have acted, in respect to the manufacture of telegraphs, in a manner totally different from that in which they would have acted in any other operation. They begin by simply asking the contractor for what amount he would be prepared to lay down a cable in a given position, guaranteeing his performance for a limited time, as though a cable, unlike a railway or any other means of communication, were a thing which would necessarily, when once laid down, last for ever. No greater error could be committed. Nothing can be more precarious than the life of a cable. The company which, without regard to its future maintenance, provides capital for merely one cable must be fortunate indeed if such a course should not prove its ruin. The future repair, maintenance, and restoration of a cable is as important an item as the maintenance of a railway.

Capital for all these purposes should be provided, as well as for the mere construction of the cable itself. With our present experience no company would be justified in relying upon the successful action of one single cable in deep water, and two at least should be provided for in the original estimates, to meet the chances of accident in laying

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down. And beyond this, arrangements should be made that a sufficient reserve fund should be available for constant repairs, and if necessary, renewal. This is also a most important consideration in regard to the route that is selected, for although the protection afforded by deep water is evidently very great, the chances being that the life of a cable will be much longer in deep than in shallow water; yet, on the other hand, faults do occur at the greatest depths, and in such case the cable is necessarily abandoned, as no repair is possible.

III.

Summary of Principles which should govern the Construction and Laying of Submarine Telegraphs.

The materials of which a telegraph cable is composed, and the dimensions and form in which these materials are to be combined, necessarily depend upon the conditions of position, depth, nature of the bottom of the sea, and the climate in which the cable is to be laid. Each case will require special consideration and arrangements peculiar to itself, and we can only point out the general principles to which regard must be had by an engineer, in designing and laying a submarine telegraph cable.

We have already stated these general principles, and we propose now, therefore, only to give a short summary of the main points which it is necessary to observe.

The following are the points to which we would invite attention:—

A.—Construction of the Cable.

1.—*The Conducting Wire.*

The conductivity of the metal, other circumstances being the same, does not influence the amount of induction; a bad conductor, therefore, increases the resistance, the induction remaining the same. Hence the conducting wire should be formed of the material which possesses the highest conducting power which can be selected. To ensure this it is desirable, in contracts, to provide that the conductivity of the wire shall be equal to that of a standard wire at a specified temperature, and then what the wire wants in quality must be made up in quantity at the contractor's expense. It is, however, better to obtain the material with the highest conducting power, because the larger diameter of the inferior conductor would give rise to increased induction. The standard wire should be of some metal or alloy not liable to oxydise, and not subject to rapid variation in conductivity from change of temperature. The metals and alloys we have described in an earlier part of the report appear well adapted to the purpose.

The conductor should be formed of a strand of wire, or of some modification of the strand form, as before mentioned, so as to prevent the fracture of one of the wires rendering the whole cable useless.

2.—*The Insulating Covering.*

Of the materials which have been submitted to us the best insulator by far is india rubber; Wray's compound and pure gutta percha, nearly resemble india rubber in its insulating properties.

The induction discharge is directly as the length of a wire. The amount of induction discharge from wires of different diameters with coverings of various thicknesses of the same insulating material may be assumed to be, for practical purposes, directly as the square root of the diameter of the wire and inversely as the square root of the thickness of the insulating envelope.

Hence by increasing the diameter of the wire and the thickness of insulating covering in the same proportion, the amount of inductive discharge remains the same. The force of the current in a voltaic circuit increases as the square of the diameter of the wire (the length of circuit being constant, and the resistance of the battery being inconsiderable as compared with that of the metallic portion of the circuit), consequently if it be found inconvenient to increase the conducting wire, and the insulating covering proportionately, greater advantage will be obtained by increasing the diameter of the wire than the thicknesses of insulating covering, for whilst the covering remains the same, the induction discharge increases only as the square root of the diameter of the wire, whilst the force of the current increases as the square of the diameter; and if the insulating covering be varied, the the conducting wire being constant, the strength of the current will remain the same, but the induction will only decrease as the square root of the thickness.

India rubber surpassess all other materials in the smallness of the amount of its inductive discharge and the perfection of its insulation. A coating of india rubber is fully equal to a coating of the gutta percha hitherto in use of double its thickness. Wray's compound and the recently manufactured pure gutta percha closely resemble india rubber in both these respects. The mixture of imperfectly conducting materials with gutta percha has the disadvantage of greatly reducing the insulation and increasing the induction. The interposition of cotton thread between the wire and an insulating coating considerably increases the induction, and diminishes the insulation. The induction is augmented because the cotton thread, which is a bad insulator, increases the surface of the conductor; and the insulation is impaired, not only because the insulating coating is diminished, by the thickness of the cotton, but probably also in consequence of the greater inductive action. The interposition of cotton between two layers of insulating material is equally disadvantageous. The interposition of a viscid insulator between two coatings of insulating material neither decreases the induction nor improves the insulation of the line, but the viscid fluid has a tendency to fill up air holes or flaws in the insulating coatings. Generally speaking, the more perfect the insulating material is, the less its inductive capacity.

India rubber and Wray's compound are not perceptibly affected by any ordinary increase of temperature, but increase of temperature has a very decided influence in diminishing the insulation of gutta percha. This substance is, therefore, not well suited for cables to be laid in tropical regions. Temperature affects the induction discharge only in so far as it affects the insulation.

India rubber and gutta percha are subject to deterioration by exposure to the action of oxygen in the presence of solar light; but when light is excluded, gutta percha will remain for months, and india rubber for a considerable period unchanged in air, and both will remain unaltered for years in water when light is excluded; indeed sea water is peculiarly favourable to the preservation of gutta percha, especially when coated with Stockholm tar. As regards Wray's compound, we have seen a specimen of his No. 2 material, which it is stated has been exposed to alternations of temperature and exposure during two years, but sufficient time has not elapsed since its introduction to enable us to express a definite opinion as to its durability.

India rubber, gutta percha, Wray's compound, and Chatterton's compound all absorb water; the absorption is more rapid from pure water than from sea water, and more rapid from sea water than from concentrated brine. The thickness of the material affects the rate of absorption in a peculiar manner. The absorption of water by thick sheets stops short at a limit which is rapidly exceeded by thin sheets, pressure does not appear to increase the amount of absorption; and it does not appear that this absorption is to be feared as a cause of deterioration in submarine cables.

Pressure greatly improves the insulation, whilst it is being applied, and this effect is more perceptible as the substance is a worse insulator. But it does not appear that pressure asserts any influence on the amount of induction discharge.

The manner in which gutta percha can be manipulated and placed on the wire by being forced through a die, renders it less liable to flaws when laid over wire than india rubber, but india rubber is generally more free from impurity than ordinary gutta percha: the more perfect insulation afforded by india rubber, pure gutta percha and Wray's compound enables flaws to be detected, which would pass unnoticed with ordinary gutta percha. The occurrence of flaws in the insulating covering of conducting wires can be best guarded against by laying on the material in several coats, and by testing each of the coats under water at a specified temperature. These electrical tests should be continued during the covering of the cable, and whilst it is being submerged, in order that comparative results may be obtained throughout.

(To be continued.)

The Student.

We shall for the present continue in this portion of the paper to confine our remarks and instructions to the subject of voltaic electricity. In regard to static or frictional electricity, we earnestly recommend the student carefully to follow the subject-matter of the series of articles * on this branch of electrical science, now appearing in our leading columns, and which we endeavour to render equally interesting and important to the beginner, as they will, doubtless, prove to the more advanced electrician.

We may here remark, that the agency in frictional and in voltaic electricity is the same; the difference being merely in the degree of tension. But while the voltaic battery furnishes electricity in quantities limited only by the extent of surface of the battery elements, and always comparatively large; the quantity of electricity that can be obtained by means of friction is very small. With a battery furnishing electricity of very high tension, *i. e.*, several hundred voltaic

* Steps to Theory by the Practice of Electricity, commencing at p. 133.

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couples connected by their dissimilar poles, no matter how small the elements, all the effects of frictional electricity can be produced.

There are two problems relating to battery arrangements, which are of great importance to the progress of applied electricity, and which every student may contribute in some degree to solve. The first is to produce cheap electricity, due regard being paid to the conditions which involve labour, which in most cases is equivalent to expense; and the second is to construct a battery, not very expensive or troublesome, which will occupy the smallest possible space. The nearest approach to the latter is, perhaps, the Smee's battery, which is, therefore, generally used for medical coil machines, and for experimental purposes. The expense of the platinized silver which forms the negative element, and the necessity for employing a corrosive acid, are, however, objections which might possibly be avoided. The form of Daniell's battery we have recommended (p. 42) is a very *cheap* source of electricity—perhaps the cheapest in which the metal zinc is employed as a positive, and possesses many advantages which we shall have occasion to refer to. Greater power in smaller space might, however, occasionally be desirable for the purposes of experiment; though upon a large scale the Daniell's battery is now almost universally employed.

In forming *data* from the results of our experience of any form of battery, it will be necessary to ascertain, in regard to our first problem, 1st, the quantities of material expended in a certain space of time; 2nd, the quantities (if any) of the products obtained, *i.e.*, the battery residues which may have any commercial value; 3rd, the conditions of the current from the battery—in regard to quantity and tension, and whether these conditions are constant or variable.

In order that these data may be approximatively compared to others, we would recommend that a galvanometer, as nearly as possible of the same form and size as that figured at page 58, be employed to measure the *quantity* of the current. The amount of deflection obtained upon this (or upon any other quantity galvanometer which may be used) with a Daniell's battery of specified surfaces—the zinc element of which is immersed in a saturated solution of sulphate of zinc, and the copper in a saturated solution of sulphate of copper—may, for greater certainty, be stated. We have found, however, that with several galvanometers constructed with due care by different persons, according to the instructions we have given, a uniform indication with the same battery has been obtained.

To determine the tension of the current so as to admit of comparison is perhaps the most difficult point. As the student will not be always provided with long lengths of fine wire for "resistance coils," the following will perhaps be the readiest means to ascertain this point:—

Construct a rectangular trough, of gutta percha or of wood, made water-tight by varnishing or otherwise, about six inches in length—inside measure, one inch in breadth, and one-and-a-quarter inch in height. This will be just of sufficient size to hold transversely two pieces of tinned iron plate one inch square, and to allow of their being covered with water. On the upper edge of one of the sides of the trough, mark the number of inches the plates may be apart in the fluid, and subdivide the inches into quarters. The tin plates should have a projection, to allow of the wires of the battery being attached to them. The mode of employing this arrangement, to determine the tension of the current, is as follows. After having noted the deviation of the index of the galvanometer, when the terminal wires of the battery are connected directly with the mercury-cups of the instrument, connect one of the terminals with one of the tinned plate electrodes placed at the extremity of the resistance trough. The end of the other terminal wire is to be immersed in one of the mercury-cups of the galvanometer. The second mercury-cup is to be connected by means of a short piece of wire* with the second plate of the resistance trough, the trough being nearly filled with rain water, or better, with distilled water. Our object now is to interpose in the circuit a resistance which will reduce the original deflection on the galvanometer to about one-half. For this purpose we first place the two squares of tinned plate at the extreimties of the trough, and then move them towards each other until we obtain the amount of deflection required. We then note the length of the column of water, one inch square, through which the tension of the battery current enables a certain portion of the electricity, indicated by the quantity galvanometer, to pass. It may happen that the tension of the current is insufficient to overcome to any appreciable extent the resistance offered by pure water. In this case as much common salt may be added to the water as it will dissolve, and the experiment may be repeated under these conditions. It should be understood that the *data* that may be obtained and given by these means may not be susceptible of any great accuracy; but are sufficient for the purpose in view, of enabling us to arrive at conclusions of practical value in regard to the relative advantages, in point of efficiency as well as of economy, of various battery arrangements, and to compare our results with those obtained with other forms of battery by other experimenters. The turned plates when discoloured (at the negative terminal) or corroded (at the positive terminal), should be replaced by others; or a piece of platinum foil, if obtainable, may be employed as a permanent electrode. The observations upon the quantity and tension of the current may be repeated each day for a certain period, at the end of which the consumption of materials may be estimated.

In our next number we will describe various forms of battery occasionally employed, and point out the principles upon which their efficiency mainly depends, and their relative advantages in point of convenience and economy. The learner must not fall into the common error of supposing that a current of greater power can be obtained from a given arrangement, such, for instance, as the Smee's battery, than can possibly be produced with any other arrangement, such as the Daniell's battery. The supposition holds good only in regard to equal surfaces or an equal number of alterations. By increasing the surfaces in the Daniell's battery—as may be done either by augmenting the size of the plates or by connecting together the similar metals of several couples, we increase the quantity of electricity supplied from the Daniell's arrangement; and, by uniting together several couples, or series of couples, by their opposite poles, we increase the tension.

* The ends of the (copper) wire to form contact with mercury, and also the terminal ends of the galvanometer, should either be freshly brightened, or "amalgamated" by dipping in nitric acid, rubbing in a globule of mercury, and removing excess of acid.

PORTABLE IRON HOUSE FOR THE TELEGRAPH STATION AT JUBAL.

The iron building, constituting both a dwelling house and a telegraph office, for the Station of the Telegraph to India Company on the island of Jubal in the Red Sea, consists of four rooms (about ten feet square each), viz.: instrument room, kitchen, and two bed rooms, framed in the most approved manner, and lined outside with corrugated galvanized iron, having two gabled ends fitted with ornamental cut barge boards and turned fineals. The inside is lined with match boards of best pine, stained and varnished. Each window is fitted with loosened shutters and folding casements, glazed with green cathedral glass. The interior has been fitted as follows, viz.: desk, table, and stools, for instrument room; one of the latest improved French kitcheners, with roaster, large cupboard, table, and stools for kitchen; also every requisite in the culinary department, with the necessary requirements in china and glass. The bed rooms have three folding iron bedsteads, and portable wash-stand, &c., complete. Externally, the building presents a very light and elegant appearance. After having been put up complete and examined, and approved of by several of the directors and gentlemen belonging to the Company, it has been taken to pieces, carefully marked at every joint, and packed in sixteen cases, and shipped on board the Peninsular and Oriental Company's steam ship *Indus*, which sailed on the 4th. The construction and fitting was executed under the direction of Sir C. Bright and Mr. Latimer Clark in a very creditable and satisfactory manner, by Mr. Alexander M. Greig, builder and contractor, Chapter Street, Westminster.

INSULATION AND CONSTRUCTION OF SUBMARINE CABLES.—No. 2.

[Continued from page 124.)

In a former article I had occasion to quote evidence from the Government Report, showing the superior qualities of india rubber as an insulator, even under the disadvantageous circumstances of decomposition. And while it was much to be regretted that on the first introduction of caoutchouc for that purpose decomposition should have ensued (not that it can prevent the ultimate adoption of rubber as an insulator), I gave some general hints as to the means which should be used in order to prevent decomposition. And so satisfied am I of the efficacy of the means alluded to, that I do not think it necessary to make further reference to the matter, except that caoutchouc insulated wires, manufactured latterly, have been far superior to those tested by the electricians appointed by Government, from the fact that a noble spirit of emulation has actuated the manufacturers in adopting, and carrying out the preventive measures above referred to. In passing, therefore, I may be allowed to congratulate the public upon one important step having been made, viz.: the introduction of a first class insulating agent, which can be effectually applied to the wire. From

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this digression I now proceed to the more immediate object of this paper.

It is indispensable, as before stated, that the purest copper wire should be employed, in order to give the least resistance to the electric current, for the length of cable required. It is equally indispensable also that the diameter should be accurately ascertained by some definite rule. For this purpose guages are employed, and it is a remarkable fact that no two of them are alike. The true diameter of copper wires, however, can be found from the following simple formula, which appeared in the *Mechanic's Magazine* and the *Engineer* a few months back:—$d=\cdot5\sqrt{\frac{W}{l}}$; where (d) denotes the diameter in inches, (W) the weight in ounces, and (l) the length in inches. I may here remark that it is essential to have the conductors for submarine cables formed into a strand.

Now the diameter of a strand thus formed is greater than a single wire containing the same sectional area, because of its spiral form. It is therefore necessary that the electrician and manufacturer of submarine cables should have some definite rule to guide them, previous to covering a spirally formed conductor with any given weight of the insulating material. In order to be perfectly understood, let us suppose that a copper strand containing seven wires, and having six of them laid spirally round the centre one, thus making the diameter of the strand equal to three of the wires forming the conductor. Now, having found the diameter of one single wire (forming a part of the strand conductor), by the preceding formula, and multiplying it by $\frac{3\times5}{6}=\frac{5}{2}$, thus;— $\frac{5\times\cdot5}{2}\sqrt{\frac{W}{l}}=1\cdot25\sqrt{\frac{W}{l}}$, gives the diameter (d) of a conductor thus formed; whereby we can calculate the thickness of the dielectric for any given weight of the insulator. This formula will be better understood as we continue the subject. It is an admitted fact that the thickness of the insulator for submarine cables ought to be an important consideration in their construction. By way of illustration let us suppose that the electrician requires the thickness of the dielectric on a conductor of any given diameter (d), as found by either of the preceding formulas; also let (W) denote the weight of the insulator, (S) its specific gravity, (l) the length of the conductor, and (x) the diameter of the cable. By calculation $x=\sqrt{\frac{Sd^2nl+cW}{nlS}}$, and the thickness of the envelope is $=\frac{x-d}{2}$ as required. Having given the value of x, and making it equal to D′, and substituting its value in the preceding equation, we then can find the weight (W) of the insulation for any required length of cable. Thus:

$$D'=\sqrt{\frac{Sd^2nl+cW}{nlS}};$$

$$D'^2=\frac{Sd^2nl+cW}{nlS};$$

$$D'^2\,nlS=Sd^2nl+cW,$$

$$cW=D'^2nlS-Sd^2nl.$$

Therefore the weight $W=\frac{D'^2nlS-Sd^2nl}{c}$; where (c) is=1728; (n)=·7854.

By substituting the value of the foregoing equation (1) in Professor Thompson's formula, the rate of signalling through a stated length of submarine wire may be ascertained. He states that "The rate of signalling attainable through a stated length of submerged wire is inversely proportional to the capacity, and directly proportional to the sectional area, and to the conductivity of the metal employed for the conductor, hence for the same quality of wire, the rate of signalling is proportional to D^2 log. $\frac{D'}{D}$, where D denotes the diameter of a copper wire of circular section symetrically covered with the insulating agent to a diameter D′, and log. denotes the Naperian log. of the number to which it is prefixed."

The author will have to make frequent reference to those formulæ in his forthcoming papers on the subject of telegraphy.

Scrutator.

February 4, 1862.

(To be continued.)

EARTH CURRENTS.

The Astronomer Royal reports:—"I alluded in the last Report to the possible establishment of galvanic wires which would record, perhaps, upon the same photographic sheets which bear the declination and horizontal force, the magnitude and direction of earth-currents in two directions. I conceive that this may be justly regarded as an important physical experiment; and I hope to be able shortly to lay before the Visitors some details of plan, and to ask their opinion in a more precise form."—1861, June 1.

It may be mentioned that the opinion of the Board of Visitors was taken, and that they approved of the proposition. It was then submitted to the Admiralty; and the grant of money necessary for carrying it out has been obtained. Dartford and Croydon have been selected as the places where the Greenwich wires will terminate. Mr. Walker is preparing to erect the wires, all arrangements being completed.

THE FAILURE OF THE ATLANTIC CABLE.

[Continued from page 112.]

The following is the Report of Mr. W. T. Henley upon the condition of the Atlantic cable after it had ceased working:—

To the Chairman and Directors of the Atlantic Telegraph Company:

Valentia, *Sept.* 30, 1858.

Gentlemen: In accordance with your instructions, I have, since my arrival here on the 8th instant, carefully tested the cable at various times, and with different degrees of battery power, and have found its insulation seriously impaired, and the results of the testing led to the conclusion that the injury is at a considerable distance from this (very nearly 300 miles of the cable apparently intervening between this point and the fault).

As I think it right you should know on what grounds and by what modes of operation I and others have arrived at this conclusion, and as you may also like to be informed as to some of the phenomena of electrical science as shown in connection with this cable, I have ventured to go a little into detail, hoping thereby to convey some information that may not be unacceptable.

On connecting one pole of a voltaic battery with the end of the cable with a galvanometer in circuit, and the other battery pole to earth, I find the current meets a resistance to its passage equal to two hundred and ninety miles of the copper conducting wire of the cable, and as the cable is more than two thousand miles long, it is therefore evident that the greater part of the current finds a shorter route to the earth.

By resistance is meant the impeding force that electricity meets with in its passage through conductors of all kinds, metallic or otherwise, and which varies immensely, not only in various metallic and other bodies, but also in the same kind of metal, and this can be accurately measured even in one inch of wire. Taking any given metal, the conductibility of which is uniform, the resistance of the wire will be found to increase as the size decreases, exactly in proportion to the sectional area. A mile of No. 40 copper wire is thus found to resist as much as 175 miles of the conducting wire of the Atlantic cable. It is necessary also that the fine wire should have been previously tested with some of the cable, as wires of the same guage are frequently found to vary very much in size as well as in conductibility. Knowing the resistance per yard of the fine wire, to obtain that of the cable comprised between the point of operating and the fault (and thus to find its length), the battery and galvanometer are connected with the line and earth in the before-mentioned manner. The degrees of deflection are accurately read on the galvanometer, and this process is repeated several times with batteries of different degrees of strength; the batteries and galvanometer are then disconnected from the cable and earth, and connected with coils of fine wire, the length of which latter is added to or diminished until the readings of the galvanometer exactly coincide in every case with those noted when connected with the cable. The length of the fine wire will then give that of the cable up to the point at which the battery current finds earth, reckoning about one mile of cable for every 10 yards of wire. There are several methods of doing the same thing, but they are all based on the same system of proportionate resistances.

There is next the resistance of the fault itself to be taken into account, for, strange as it may appear to some, faults (in proportion to their magnitude) may be equal in resistance to from one mile to several hundres of miles of cable, and would give the same indications on a testing instrument. If we knew the exact nature of the injury, and how much of the copper was exposed, we could, with tolerable certainty, tell at what distance it existed; but in the absence of such knowledge we must judge from appearances, making use of any previous experience we may have had in matters of a similar kind. And, firstly, we know if much of the resistance was produced by the fault, it must expose a very small amount of surface, and that on

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sending positive currents, the wire (by electrolytic action) would be oxydized at the faulty spot, and the galvanometer would show that the fault was partially repaired by the non-conducting power of the oxyde.

On reversing the direction of the current, hydrogen would be evolved, which, by reducing the oxyde and cleaning the wire, brings the fault back to its former state. Should it be of considerable size, and consequently of small resistance, the coat of oxyde would be thin, and quickly reduced by reversing the current, showing that very little alteration was produced by changing its direction.

Precisely this effect is produced by sending currents into the cable, indicating the injury to be of that character. A small fault could not reduce the strength of the signals to the extent we find them, unless the wire was separated near that point, and this (which is quite within the range of probability) would set our calculations at naught. That the cable is not severed we have abundant proof, but that any one can, by the most delicate tests, discover whether the conducting wire is so or not in a cable of this length I utterly deny. Should such be the case, it does not follow that the line must be rendered useless, as I have known underground telegraphs to work for monts after the conducting wires had been separated more than a quarter of an inch by the decomposing power of the batteries employed. A slight failure existed in the gutta percha; this admitted moisture, which, by conveying the electricity to the earth, caused the decomposition of the wire, and then aided the working of the telegraph by conducting a portion of the current from one point of the separated wire to the other. Signals were much reduced in power, as in the present case; still the wire continued to work, and if such can be done for months, it might happen for a longer period.

If, by any means, the conducting wire separates, and the gutta percha remains sound, all communication ceases, from the absence of moisture to complete the circuit. By our testing, one fact is unquestionably established, and that is, the fault is not beyond 300 miles. I I speak of the great fault; others may exist between that and Newfoundland, but if it be a fact, as I have heard, that, on testing at the latter place, very little earth is shown, the probability is that the other part of the cable is good. Having arrived at the fact of the injury not being beyond 300 miles, the difficulty is to know how much within that distance it is to be found, or how much of the resistance is due to the cable, and how much to the fault; and although by accurate testings and examinations a pretty correct knowledge of the facts may be obtained, still it is liable to some uncertainty, and instances have occurred in testing cables where the most experienced have been quite wrong in their conclusions.

I cannot think it possible for the injury to be in the harbour, but should think it advisable to lay down some length of shore end, as the cable near the land must soon be injured by friction on the rocks and shingle. A piece of the same size, laid across the harbour for the Magnetic Company, was entirely worn asunder tome days since.

In my opinion the fault or faults existed in the cable before it was submerged, and that they would have been detected and made good had the precaution been observed of having the whole cable tested in water during its manufacture.

Its not showing so bad when first laid is easily to be accounted for, as it takes some time for the water to soak through the coating of pitch and tar. In a cable I am now manufacturing a fault was four days in the water before showing anything.

Had your cable been injured after submersion by resting on the sharp edge of a rock, the inner wire and the outer metallic covering must have come in contact, and that this is not the case we have absolute proof, both from the fact of a battery current being generated by the iron sheathing and the exposed copper, and from signals being received from Newfoundland; for, did the iron touch the copper conductor in the smallest point, not the slightest signal could be observed. Signals were from the first much weaker than they ought to have been from a tolerable insulated line of that length, and were scarcely sufficient to work a very delicate relay, which can be used with a current so feeble that it could only just be detected on the tongue. The currents now received are not more than a tenth of that power, and can only be indicated on Professor Thomson's very ingenious reflecting galvanometer. This is constructed on the principle of the boys' "trick" of receiving the rays of the sun on a piece of looking-glass and reflecting them on the wall, a very small motion of the hand giving a range of many feet to the spot of light. Professor Thomson attaches a small mirror to the magnetic needle of a very delicate galvanometer of his own contrivance; the light of a lamp is thrown on the mirror, and a motion of the needle that would be inappreciable in itself is plainly indicated by the reflected spot of light on a scale. The apparatus could be made much more delicate still, and capable of working with the smallest amount of current, but there is an obstacle in the way of using such a feeble power, and that is the earth current, which shows itself at all times more or less.

(*To be continued.*)

GOVERNMENT SUPERVISION OF TELEGRAPH LINES.

We are happy to be able to state that the telegraph lines under Government control have been placed under the direct supervision of a responsible officer of the Board of Trade.

The appointment of Government Superintendent has been conferred upon George Gibson, Esq., a gentleman who has had considerable experience in telegraphic matters in connection with the late Government inquiry and the general operations of telegraphy, as brought before the Board of Trade. These telegraph lines are now, therefore, brought under the same category as other Government undertakings of similar character; a step we have advocated since the commencement of this periodical, and which cannot fail to be of advantage to the public.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	1s. 11d. to 2s.	per lb.
Negro	1s. 5d. to 1s. 7d.	„
Java	1s. 5d. to 1s. 6d.	„

Gutta Percha.

Fine	2s. to 2s. 3d.	per lb.
Inferior and Re-boiled	8d. to 10d.	„

February 12, 1862. Wm. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do B. 7 per cent. till 1862	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
Stock	Electric Telegraph . .	100	98 to 101	——
20	Red Sea and India Telegraph	all	19 to 19½	——
1	Submarine Telegraph, scrip.	all	3/8 to ½	——
1	Do. registered . . .	all	3/8 to ½	——
10	Do. „ . . .	all	4 to 6	——
5	United Kingdom Telegraph .	2	1½ to 0½ dis.	——
	Mediterranean Extension Tel.	all	4 to 5	——
	London & S. of Ireland Direct.		¼ to ¾ prm.	——

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

ATLANTIC TELEGRAPH.

To the Editor of The Electrician.

Sir,—The recent events, and the present state of affairs in America, have convinced every commercial man in this kingdom, of the importance direct telegraphic communication being established between England and America, and, from the reliable evidence we are in possession of, renders it quite a certainty that this great enterprise might now be safely carried out. We, some short time since, heard of a report which said that Messrs. Glass and Elliott were prepared to lay down a cable for the sum of £700,000, but this offer, it appears, was not accepted, The Government of this great nation cannot be unmindful of the desirableness of encouraging every legitimate means to further this object, and if the concessions granted to the original company, could by any means be withdrawn, we probably should then have the opportunity of hearing from various contractors the terms upon which they would undertake this great national undertaking, and successfully carry it out. The scientific experiments which have been carried on seem to have quite settled the question as to the construction of the insulator which appears to possess all the requirements necessary for this line or any other; this being so, there is no need of further consideration on this point; but with respect to the internal sheathing, there is no doubt that many failures have occurred by the strength required for deep sea lines not having been well understood, or that sufficient and reliable calculations had not been made previous to the commencement of operations, which of necessity is very important, as there is probably a great difference required in the construction of every separate cable, and I have been much struck with what I have thought to be a great mistake, viz., that for deep sea lines we have not had cables sheathed in such a manner as to avoid untwisting, kinking, and elongating, as most assuredly must be the case with all spiral covered cables when being laid in water at the depth of 2,000 fathoms, and in some parts much more, so that from the recent experiments, cables of a light specific gravity are required, and, to

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insure success, must be constructed in such a manner as will enable them to bear double the strain they are calculated to sustain. If this could be so, which I doubt not, the sooner some definite assistance is offered by the Government the better, as I am persuaded that there are thousands of thinking men throughout this country at the present moment who are estimating the probable cost of the war preparations connected with the *Trent* affair, and also the amount that might have been saved in this great outlay if we had possessed telegraphic communication; and from recent information it appears to be considered by the Americans themselves, of vital import to them, as a nation so closely united to us, in every thing appertaining to commerce, and the general advancement and encouragement of the unity of both countries.

If what we hear be true, that Mr. Cyrus Field is coming here with propositions from the American Government, for the purpose of assisting our own Government to carry out this object, it is hoped that the propositions about to be made will have their due weight on the meeting of Parliament, and that the members of the Ministry will be unanimous with a scheme to support all legitimate propositions that may be made to them, as, if this cable is laid, there is not the slightest reason to anticipate but that it would be a source of profit to both nations as a good and sound investment, and be always available for use in every emergency, and the many and numerous advantages that will arise cannot be enumerated or comprehended, by supposing the thing already accomplished. And this is becoming of more importance every hour, as there is no doubt that if Canada is worth our protection, which is not doubted, that the saving alone to us, by having constant communication with the army there, would be immense. Thus, as a national undertaking, the advantages are incalculable, and our great politicians, Mr. Bright not excepted, could not but be one of the foremost in advocating this project. As we all know what good the great "civiliser" has done, I mean the railways, in Europe and in India, and might it not be said that communications by telegraph, in keeping up a continuous intercourse with distant lands, must be the the means of satisfying the most sceptical of the great advantages to be derived as a national, political, and economical investment.

And if the importance of events within the last few months has caused an outlay to this country of several millions, why should there not be a sum expended which would not reach one million for a purpose which would encourage every good feeling to exist between ourselves and the Americans.

In passing, I would suggest the propriety of investigating the various opinions of telegraph engineers and referees, to ascertain the real value of the opinions which they have given, and also, if possible, the correct reasons for the great changes that have taken place by many who ought to be very valuable in legitimately furthering this great national science, the mystifications that appear, and the unaccountable sudden changes that are daily taking place, render it very difficult to comprehend, and much more difficult to place that reliance which ought to be placed, and depended upon by the public at large, to encourage investment of capital required for this and other undertakings.

The science of telegraphy is rapidly changing its character, and the more we say about it the better, as, with the assistance of your valuable Journal, the public attention is brought to bear, and, as one of your correspondents remarked, that one of the letters published was the opinion of some idle scribbler, be this as it may, there is probably something to be gained by the publication of every letter bearing upon the science of telegraphy, as out of very minute specs of information great results have been obtained; look to the perfection of the steam engine, and many other inventions which have been completed by combining the ideas of several persevering and studious men.

Sir, in conclusion, I would say that having seen so much capital expended with such small results, it behoves the public to ascertain for themselves before investing their capital for the purposes of a new telegraph to America, to note well the officers appointed as mechanical engineers, and telegraph engineers, as these are the men who should be beyond any influence, and capable of acting with firmness, and be able to carry out and maintain their own opinions, and have manufactured under their own special guidance and control, to successfully lay a new Atlantic telegraph.—I am, sir, yours obediently,

Truth.

"THE COIL CURRENT."

To the Editor of The Electrician.

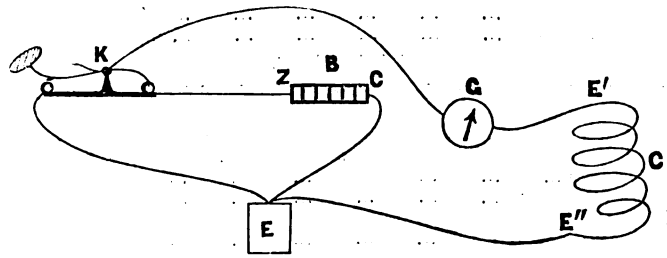
Sir,—If you think the following experiments of sufficient importance, or in any way calculated to assist those who are discussing the phenomenon of the "Coil Current," through the medium of your journal, you will, perhaps, allow them to appear in your next number. I think by publishing them you will at any rate settle two points upon which your correspondents appear to be divided in their opinions, viz.: the length of insulated conductor necessary to develope the phenomenon, and, that it is not essential that the insulation should be imperfect, as one of your correspondents cunningly insinuates.

As pressure of business will not allow me to enter as fully as I should wish into the subject, I think it best to give the experiments as tried, with the results obtained, leaving it for those who are interested in the subject to draw their own conclusions.

The galvanometer used in the experiment was a small astatic fibre suspension.

The battery an ordinary copper and zinc, size of plates 4·5×3·5 inch, excited by diluted sulphuric acid.

Connections arranged as shown in rough sketch.



K. Key. G. Galvanometer.
B. Battery. E′. Top end of coil.
E. Earth. E″. Bottom end of coil.

First Experiment.

Two coils, 2,640 yards each in length, containing a copper conductor, the diameter of which was ·084 in., insulated by three coatings of gutta percha and three of compound to ·340 external diameter, were connected so as to make one length of 5,280 yards, and submerged in water, the temperature of which was 55° F.

With E″ insulated the discharge was with

12 cells	... ...	4 left
24 „	... ...	7 „
36 „	... ...	12 „
48 „	... ...	14 „
60 „	... ...	19 „
72 „	... ...	23 „
144 „	... ...	44 „
204 „	... ...	64 „

With E″ to earth the discharge or "coil current" was

With 12 cells	... ...	65 right
Repeated	... ...	7 left
„	... ...	7 right
„	... ...	100 „
„	... ...	95 „
„	... ...	16 „

Placed between E and E″ a resistance equal to 512 miles of the conductor under experiment.

With 12 cells	... ...	8 right
Repeated	... ...	3 „
„	... ...	8 „
„	... ...	8 „
„	... ...	3 „
„	... ...	3 „
With 24 cells	... ...	3 „
Repeated	... ...	0
„	... ...	3 „
„	... ...	2 „
With 504 cells	... ...	0
Repeated	... ...	0
„	... ...	0

Resistance removed from the circuit:

With 504 cells	... ...	40 right
Repeated	... ...	49 left
„	... ...	52 „
„	... ...	24 „

Second Experiment.

The same two coils as used in the first experiment joined in one length and wound very regularly on an iron reel, and then submerged.

With E″ insulated the discharge was, with

12 cells	... ...	4 left
24 „	... ...	7 „
36 „	... ...	12 „
48 „	... ...	15 „
60 „	... ...	19 „
72 „	... ...	23 „
144 „	... ...	46 „
204 „	... ...	68 „

E″ to earth.

With *one cell*.—The needle of the galvanometer was very powerfully affected, starting from the right.

Placed in the circuit between E and E′ 512 miles of resistance.

One cell	... ...	10 right
Repeated	... ...	9 „
„	... ...	10 „
„	... ...	10 „
„	... ...	10 „
„	... ...	10 „

Resistance reduced to 256 miles:

One cell	... ...	18 right
Repeated	... ...	17 „

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Resistance increased to 768 miles:
One cell ... ... 7 right.
Resistance increased to 1,023 miles:
One cell ... ... 4 right
12 cells ... ... 62 „

Third Experiment.

One mile of a copper strand ·075 diameter, insulated by three coverings of gutta percha and three of compound to ·340 external diameter, submerged in a loose coil, in water, the temperature of which was 55° F.

Insulation test with 504 cells.

Loss 0
Discharge ... ... 55 left
E″ to earth.
With *one cell* ... ... 5 left
Repeated ... ... 3 right
„ ... ... 2 left
„ ... ... 4 „
„ ... ... 5 „
„ ... ... 5 „
With 12 cells ... ... 10 right
Repeated ... ... 5 „
„ ... ... 9 left
„ ... ... 14 „
„ ... ... 14 „
„ ... ... 13 „
With 24 cells ... ... 12 right
Repeated ... ... 9 left
„ ... ... 5 right
„ ... ... 7 „
„ ... ... 9 left
„ ... ... 7 right.
With 36 cells 0
Repeated ... ... 8 left
„ ... ... 7 „
„ ... ... 7 right
„ ... ... 2 left
„ ... ... 4 „

Fourth Experiment.

The same length of wire as used in the third experiment, wound very evenly on to a *wooden* reel, and then submerged.

Insulation Test.

Loss 0
Discharge ... ... 52 left
E″ to earth.
With one cell ... ... 4 right
Repeated ... ... 3 „
„ ... ... 4 „
„ ... ... 5 „
„ ... ... 3 „
„ ... ... 2 „
With 12 cells ... ... 18 right
Repeated ... ... 3 „
„ ... ... 8 „
„ ... ... 15 „
„ ... ... 16 „
„ ... ... 5 left.
With 24 cells ... ... 17 right
Repeated ... ... 4 „
„ ... ... 15 „
„ ... ... 10 „
„ ... ... 8 „
„ ... ... 4 „
With 36 cells ... ... 10 „
Repeated ... ... 12 „
„ ... ... 15 „
„ ... ... 9 „
„ ... ... 7 „
„ ... ... 10 „

Fifth Experiment.

The same length of wire wound from the wooden to an *iron* reel, and again submerged.

Insulation Test with 504 Cells.

Loss 0
Discharge ... . 53 left.
E″ to earth.
With one cell ... ... 73 right
Repeated ... ... 76 „
„ .. .. 65 „
„ .. .. 70 „
„ ... ... 76 „
„ ... ... 60 „

With 12 cells the needle of the galvanometer was very powerfully affected.

Placed between E and E″ a resistance equal to about 400 miles of the conductor under experiment.

With 12 cells ... ... 7 right
Repeated ... ... 7 „
With 24 cells ... ... 8 „
Repeated ... ... 7 „
With 36 cells ... ... 5 „
Repeated ... ... 4 „

The resistance removed from the circuit:

With 36 cells ... ... 20 right
With 12 cells ... ... 80 „
Repeated ... ... 100 „
„ ... ... 65 „
„ „ „ „ } The deflection was equally powerful as when first tried with this power before the resistance was placed in the circuit.

It appears to me that the discrepancy in the direction of the current from a loose coil may be accounted for by the fact that in such a case each turn of the wire is very irregular in its position to the next turn, which is not so when coiled evenly upon a reel. I have, during my experiments, noticed that when the direction of the current has been very capricious, if resistance were applied between the galvanometer and earth, as in the first experiment, the deflection became at once uniform, and in one direction, and that reverse to the true discharge.

There are many points to which I could call attention, but time will not allow me. I therefore conclude by hoping that these remarks will be received in the same spirit in which they are offered, my only object being a desire to add my mite towards assisting those who, like myself, are anxious to attain the truth.

Willoughby Smith.

To the Editor of The Electrician.

Sir,—For some time past I have been experimenting with iron wire for coil machines, and likewise with iron plates for the battery, using the Bunsen form of battery with common, well-selected coke broken into very small fragments, and the porous cell filled with them, a piece about three inches long and one inch diameter, which may be cut from a piece of coke with a rasp. This I insert about two inches into the porous jar before quite filling it with the small coke, and then fill to the top, which retains the piece secure for attaching the wire for the electrode. I find that the power of iron is equal to zinc (for the same surface), if the acid solution is used about three times the strength, and the carbon is charged with common nitric acid, and *very much more* constant, as the battery remains in action for a much longer time without any more acid being added, as the sulphate of iron which is formed is again dissolved, still liberating its sulphuric acid to again attack the iron, which is not the case with the sulphate of zinc, which accounts for the longer time the power of the iron battery continues without any abatement, and it appears to me that the battery would continue to perform until all the iron was dissolved, and the solution became thoroughly saturated, but the solution would still retain the free, and, *quaere*, would it still perform with more iron added? the precaution necessary for the regular working is to wash the iron plates thoroughly, that they may not rust when not in use, or it will be some time before the battery will be in action when commencing afresh. I think that electricity produced by these means will be found very cheap; my battery, containing 1 square foot of iron surface, with porous cell 8 inches high, which will ignite 1 inch of iron wire to white heat, cost me 1s. 9d., acid and everything included. The iron plate is 24 by 6, and wound round the porous jar in the form of Mr. Hare's galvanometer. If you think there is anything new in this (and I have never read of anything being made in this form) you are quite welcome to publish for the benefit of other amateurs like myself. In my next I shall be happy to give you a description of a very powerful coil made of *iron zinc*, which gives unbearable shocks, which, if you could be kind enough to give me a *full* description of M. Fizian's condenser, and how it is attached, may be made much more powerful. I have read through "Noad's," "De la Rive's," and "Ladd's," "Treatise on the Induction Coil," but their description of this apparatus (the condenser) is not made very apparent to an amateur, and as it very much increases the power, I shall esteem it a favour if you will oblige—Yours respectfully,

J. Cook.

To Correspondents.

L. L. S. and J. P.—An illustration of the electrical machine described in No. 13 will appear next week.

F. H. Sewell.—To test the insulation of your wire, connect one terminal of the battery to earth, and the other terminal to line through a galvanometer. The other extremity of the line wire is to be insulated. If any deflection of the galvanometer is observed, it indicates the amount of leakage. Your other questions will be answered in an early number.

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The Electrician.

Vol. I. No. 16.—February 21, 1862.

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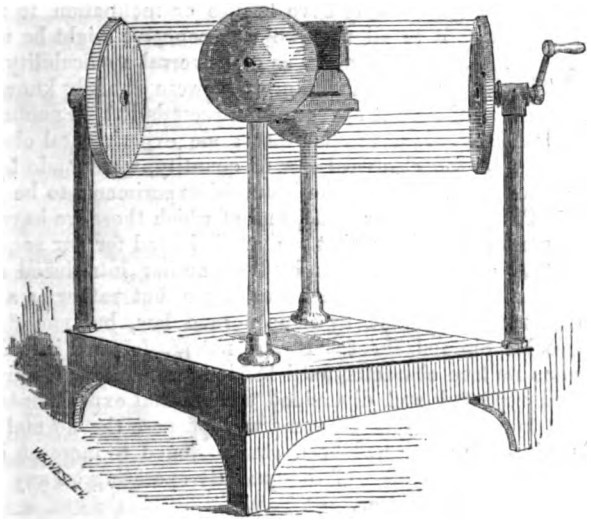
STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 170.]



THE ELECTRICAL MACHINE.

37. When the student shall have prepared the pieces of apparatus we gave instructions for, and made himself dexterous in their use, by experimenting with various lengths of discharge between the balls of one of the electrometers, and different weights in the scale of the other, he may adjust his instrument and carefully repeat Exp. 9, recording the number of grains weight he deposits in the scale *a* (fig. 2), and the number of sparks requiring to be thrown upon the disc *c*, and the conductors in communication with it, for causing *b* to descend. After doing so he may then proceed to make the following similar observations, in order that they may be compared with the others.

Exp. 10. Instead of the weight last used, put into the scale others *four* times as great in amount; and having, of course, uninsulated for a moment all the conducting parts of the apparatus, that every trace of the old charge may be dismissed, cause the cylinder again to revolve, all other things but the weights continuing exactly as before. The discs will now come together so soon as *double* the former number of electrical sparks have passed through the electrometer.

Exp. 11. On repeating the same experiment with *nine* times the amount of the first weight, the resistance it will oppose to the descent of the upper disc, under the force of its attraction by the lower disc, will be overcome by a *threefold* number of electrical sparks.

38. It is presumed that the student will have found out by practice what weights and distances suit his apparatus best; but still the following general information will be useful. Under any given electrical charge the resisting weight in the scale will need to be greater as the discs are of larger diameter and placed closer together: and also the weight and the interval between the discs being given, the sparks passing between the balls of the discharging electrometer will need to be more numerous, as the jar in connection with them exposes a greater extent of coated surface; and particularly so if also the balls be placed closer together, because in that case each spark will be proportionately smaller. He will learn causes for all these facts as he becomes initiated into the theory.

39. The three terms obtained by experiments 9, 10, and 11, afford, by comparison with one another, a very remarkable ratio between the quantities of electricity in action and the forces therefrom resulting, one that has no known parallel in fact, and perhaps in importance, within the whole range of physical science. Without our knowing why different masses of common matter tend to come together by virtue of the force that we call the attraction of gravitation; we have been enabled, by our observations of bodies, to learn that if a given quantity of any one of them gravitate with a force represented by unity, then two such quantities of the same kind of matter will have double the gravitating force, and so on, the quantities and the forces increasing together in simple proportion. But with respect to the force with which electricity attracts common matter, observation teaches that another law of proportion between quantity and attraction obtains; for we see that while the quantities of electricity increase in simple arithmetical progression, the attractions increase as their squares. And it is well known that the same law of proportion is to be observed however much we multiply our experiments by adopting intermediate weights, or by substituting other methods of operating.

40. This law of the squares of the quantities is of such importance that no pains taken to verify it can be ill-bestowed; and as it may be that in this early stage of our progress, we may have readers not experienced enough to feel confident that the relative quantities of electricity really acting between the two discs in the preceding set of experiments, were truly represented by the relative numbers of sparks passing through the electrometer, we shall vary our arrangements in a way that we think will banish from their minds all doubt upon the point. This we shall do, not because the student is in danger of finding the facts anywhere disputed, but because we think the more familiar he becomes with them, the less disposed he will be to lose the immense advantages they will be found to offer, by allowing their indication to be frittered away by any arguments that will not bear criticism; and of which he is not quite free from peril.

41. However disinclined our readers may be to admit anything not absolutely necessary, that they have not seen clearly demonstrated (and that is just the state of mind we wish all electricians to be in), they will have no difficulty in concluding that if either of two insulated spherical conductors, precisely alike, surrounded by like external circumstances, and in contact with one another, have plus electricity communicated to it, it will immediately divide its charge with its fellow *equally*; for to deny the equality of the division in such a case would be to impute to two like and equal causes unequal effects, which no one grounded in the elements of science is likely to do. Now we are about to adopt that plan for obtaining, first, a moiety of a given quantity of electricity; and, subsequently, a fourth part of the same quantity, in order that their respective forces may be ascertained and compared by means of the balance electrometer, which for that purpose we must use with its hydrostatic arrangements.

Exp. 12. Remove from its connections, the insulated conductor used in the last experiment, take away the block from under the scale, and, having attached to the latter its small depending cylinder of wood, *n*, previously well soaked in water, place under it the metal cup *m*, so far filled with water that when the balance is brought by counterpoising weights to rest with its index at

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zero, about two inches of the cylinder shall be beneath the surface of the fluid. Then adjust the distance between the discs, *b c*, to an inch or more, and charge the jar, counting the sparks of electricity as they pass between the balls. When a small charge shall have been thus accumulated in the jar, incline over it one of the moveable conductors (35), held at arm's length by its foot, bringing it for an instant into contact with the brass ball; remove the conductor, which will thus have become charged, and cause it to touch the end of the wire, *f*, leading to the under disc of the balance electrometer. If the charge of the jar have been neither too small nor too great for the diameter of the cylinder, *n*, the upper disc will move towards the lower one, and come to rest without touching it, the attraction of the electricity being counterbalanced by the additional weight thrown upon the opposite arm of the balance as a consequence of its raising from the water part of the wooden cylinder, *n*. This movement of the upper disc will of course derange its original distance from *c*, to restore which put sand into the scale, *a*, in just sufficient quantity to bring the index back to zero. The weight of the sand so added will then be equal to the force of electrical attraction acting from *c* upon *b*, at their original distance, as is known by each just balancing the other. Then dismiss the attraction by touching with the finger the disc *c*; by that act we shall cause the cylinder to sink deeper into the water in proportion to the now uncounterpoised weight of the additional sand that has been put into the scale, that movement bringing back the index a given number of degrees from zero. Now those degrees, although arbitrary, will denote, relatively to all similar experiments, the weight of the added sand, and therefore the amount of the electrical attraction which the sand had exactly counterbalanced. Note therefore the number of degrees to which the index points on the scale as indicating the force of the particular measured quantity of electricity which has been acting between the discs.

Exp. 13. Repeat the process, but before putting the charged insulated conductor into contact with the wire from the under disc, after it has been against the ball of the jar—first discharged, of course, and then charged with the same number of sparks as before—stand it upon some part of the table quite away from all other objects, and slide against it one of the other similar conductors. After they have been in mutual contact, remove either of the two, and cause it to touch the wire, *f*, of the under disc; the disc *b* will again approach *c*, with a force indicated by the place of the index on the arc; but, as that force is the result of a reduced distance, it must be corrected, as before, by an addition of sand to bring the index to zero. After again discharging the attractive force, the degree of the arc to which the index passes over on the other side, is to be noted as indicating the force of attraction of a moiety of the former quantity of plus electricity acting between the discs.

Exp. 14. Repeat the experiment a third time, with this difference, after separating the second conductor quite away from the first, bring either of the two for a moment into contact with the third similar conductor; and then put either of them, after its free removal from the other, into communication with the under disc by means of its projecting wire. After going through all the subsequent steps of the experiment, as in the former cases, the degree on the arc at which the index finally rests is to be noted as indicative of the attractive force of one-fourth part of the original plus charge acting to bring the discs together.

42. Now we reason upon this series of observations in this way:—Whatever quantity of electricity was taken from the charged jar by the first insulated conductor in either of the three cases, was taken in all of them; the charge so obtained by the first conductor, was in the second case equally divided between it and the second conductor on their momentary contact, because they were alike both in themselves, and also with respect to all the circumstances by which they were immediately surrounded; the charge thus equally divided had, in the third case, a moiety still further separated into two equal quarters, by the last contact of two similar conductors under like external circumstances; so that the three quantities of electricity which acted in succession to attract the discs *b* and *c* towards each other, were relatively to one another as 1, $\frac{1}{2}$, and $\frac{1}{4}$, or in whole numbers as 4, 2, and 1. Now by referring to the degrees denoted by the index in the several experiments, it will be found that the forces consecutively in action have been to one another as 1, $\frac{1}{4}$, and $\frac{1}{16}$, or, in whole numbers as 16, 4, and 1; thus representing the force of electrical attraction, as in the previous set of experiments, to be as the squares of the quantities of electricity operating.

43. Here then are facts, as palpably displayed to our senses as any facts can be, teaching us that two equal quantities of electricity, acting conjointly, can overcome a resistance twice as great as when they both act separately; that three equal quantities united, exert a force three times greater than they could do if all the three acted independently of one another; that four equal quantities acting in concert, quadruple the force that would result as the sum total of their individual and separate agencies. And as we cannot believe the law thus divulged to be peculiar to just those observations we may have leisure or inclination to make, we must extend it to all that we can conceive might be made; that is, we must regard the law as of universal applicability.

44. The first facts of this nature that were publicly known are of recent date, though it appears from records left in manuscript by the late Hon. H. Cavendish that some experimental observations implying the electrical law of quantity, were made by him in the year 1772. It is to the beautiful experiments to be found in the "Phil. Trans." for 1834, and of which those we have produced are modifications, that we are indebted for our acquaintance with it; not that it was by their author introduced to our notice as a law of normal electrical force, but rather as a compounded ratio originated by some normal law, but modified by inexplicable circumstances. It was not put forward in what we regard as its true character until 1851, when another electrician, who had repeated and diversified the original experiments, was brought to conclude that for some wise purpose the normal force of electrical attraction had been commissioned to increase in the rapid ratio of the squares of the quantity operating on any given portion of common matter.

45. It is a characteristic and an essential feature of the theory we are discussing, that it ascribes to each particle of common matter a certain definite quantity of electricity, no portion of which it ever can for a moment cease to attract; and yet we know by observation that the quantities of electricity, combined with common matter, are not at every instant the same. The mere fact that certain portions only can exist with it in a natural state of quiescence, or as we call it, static equilibrium, teaches us to look for some explanation of the cause for plus and minus charges consistent with the doctrine of definite attraction; but that explanation, as we remarked before, we must leave until we have made a few more steps forward in our theory. This, however, we may comprehend even now: if electricity be allotted to common matter in definite quantities, then in all probability the precise natural quantity is in every case essential to the continuance of the natural properties of the substance to which it belongs; and if that be so, then we cannot contemplate its entire abstraction as a possibility, without perceiving in it a means by which all we know of physical creation might be subverted. Can we not therefore see wisdom in the making of successive abstractions of electricity from common matter to become progressively more difficult! Our experiments suggest that the difficulty increases with successive equal units removed, in the order of the following numbers, 1 for the first, 3 for the second, 5 for the third, 7 for the fourth, and so on; which is the same thing, of course, as 1 for an unit of quantity—1+3=4 for two units; 1+3+5=9 for three units; and 1+3+5+7=16 for four units. If we believe the creation to have resulted from an intellect, we should not be surprised at meeting with evidences of design.

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46. But though the ratio of the squares of the quantities is exhibited to our observation by all experiments that bear directly upon the subject, this ratio is not yet universally received as a law of normal electrical force, because it is thought (we can show with what want of reason) to violate that one of the mechanical axioms which requires that all physical effects shall vary in the simple ratio of their physical causes. The objections that have been urged may be summed up in the following expression of a philosopher who cannot prevail upon himself to adopt it.—To suppose that two units of cause (meaning electricity) can produce four times the effect of a single unit, is to allow one-half of the effect to have a cause, and the other half none.

47. Unanswerable indeed would that argument have been had electricity and electrical force been the same things; which, happily for the student, we have already shown, experimentally, that they are not (20). The philosopher to whom we have alluded is of opinion that electricity is an unembodied force, and always uses the word electricity in that sense; and that is just the point on which wholly hangs the apparent unanswerableness of his argument. Had he said that to suppose two units of electrical force can produce four times the effect of a single unit, is to allow one half of the effect to have a cause and the other half none, we should have raised no objection, for we can believe, as well as others, all that the axiom asserts about physical causes, whether they be electrical forces or any others; but we do not see it to be philosophical to believe, in opposition to the evidence of our senses—and what also the axiom does not require of us—that an unit of natural electricity must needs be commissioned with an unit of force to be put into action upon all occasions. We can illustrate this by a precisely similar case, of which we have a practical knowledge. When we commission our muscles to act, each unit of effect doubtless absorbs exactly an unit of their physical force; but we know also that there is something in the back-ground which has decided how many units of physical force they shall use upon every individual occasion; we do not commission our arm to make a physical effort equal to the resistance of seven pounds when it has only to raise one, unless we have in ignorance conceived the weight to be many times heavier than it really is.

48. Let us put this illustration in the very language we are criticising:—Every one who has sound mechanical instruction will admit that to suppose two units of muscular force capable of raising four times the weight that a single unit can raise, must be to withhold from half the effect an adequate cause; *but what if we go back a step, so that the muscular force shall be the effect, and the moral volition*, by which we commission it, *the cause!* Could we then truly come to the same conclusion? That would be to make moral causation measurable and obedient to the mechanical axioms which its physical effects, when set up, observe among one another. And can we say less of the moral volition that has put electrical force into commission, merely on the plea that its physical effects, when once set up, observe the mechanical axioms?

49. What we believe, therefore, is, that a will competent to know the end from the beginning, has seen it good to commission electricity with a force that uniformly varies in amount with certain of its necessities; and that that force, once put into operation as a physical cause, produces results that are conformable to all the principles of mechanical philosophy.

50. How this reasoning is got over we do not know; we can imagine a general indisposition to take into consideration, in systems of physics, the primary moral causation that few are disposed to doubt is at the origin of all creation; and there are some who prefer to hope, that, by a happy conception of reflections or reverberations of the normal force from one body to another, when under the action of electricity, it may some day be seen possible to reconcile the facts, which we deemed so pregnant with new knowledge, to the old and simple ratio between force and quantity. But no method of reconciling them has yet been found; and until we be furnished with one, we may be allowed to believe what we have seen, to which we are not a little prompted, by knowing that without the new electrical law of quantity, it would still remain utterly impossible for us to regard the phenomena of the science otherwise than as isolated and perplexing enigmas; whereas in its light we shall be able to reduce the electrical chaos of a century to something like system and order. That, indeed, is the only justification that the new law really needs; but still let it be well perceived by our readers, that, in going on with the ratio of the squares of the quantities as a normal electrical law, we are not called upon to abandon the dictates of reason in favour of a faith; but, on the contrary, to adopt a belief as a legitimate result of plain argument, founded upon observation. And, if we wanted it, we should have this additional circumstance to assure us; instead of seeking for similitudes to impeach the evidence of our senses, we are employing an analogy for the more promising purpose of confirming what we have seen and believe.

(To be continued.)

THE INDUCTION COIL.

The production of dynamic and static effects by the agency of voltaic and magneto-electric induction is not only one of the most wonderful of natural phenomena, but is most instructive in its bearings upon some of the practical questions of applied electrical science. There is sufficient analogy between the effects which constantly occur in the telegraphic wire, and those which are produced in the induction coil, to render the latter an instrument of peculiar interest to the telegraphist. The effect of dynamic induction in a wire placed in proximity to another which conveys a succession of currents from the battery, is one which is familiar to all practical electricians. The currents induced in the coils of electro-magnets have been noticed as causes of perturbation by most telegraphists. In the wire for electric signals, and in the primary wire of the induction coil, the "return" or "extra" current is an effect which is equally objectionable, and requires equally to be obviated. On a small scale, but with vastly increased effects, many of the phenomena of electro-telegraphy may be observed by means of the coil; and by such observation the laws which determine these phenomena may with advantage be studied.

By the improved insulation of the wire circuits, and by the substitution of a bundle of wires for the soft iron core, Ruhmkorff was enabled vastly to increase the effects of the coil. A less obvious but equally important means of increasing the efficacy of the apparatus, was the condenser suggested by Fizeau, by which the effects of the *extra current* in the primary wire, when contact with the battery is broken, is to a great extent obviated. The form of contact-breaker now employed—a description of which, from Mr. Noad's work on the Induction Coil, is given in another page—is also a valuable improvement. It is probable, however, that further improvements of great importance may be effected by carefully studying the conditions under which the effects of dynamic induction are manifested.

It appears obvious that these effects are independent of, or even occur in opposition to, the *static* inductive influence of the primary upon the secondary wire; or, in other words, it appears that dynamic induction is a phenomenon altogether distinct from static induction, and much more powerful. In the coil as at present constructed, both the inductive influences are active, and to a certain extent must counteract each other. That this is the case is evident, when we consider that the coils are disposed without any regard to the action of static induction, dependent upon the tensions in different portions of the primary wire, and that the interposition between the coils of an insulating medium of low inductive capacity does not, to any appreciable extent, diminish the effects of dynamic induction. The conditions are altogether different

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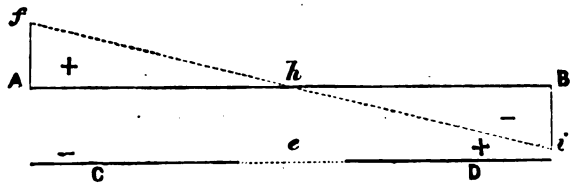
when the primary and secondary wires are placed together longitudinally, or wound together upon a reel. In this case we might explain, upon the principles of static induction, the action which takes place; but the same explanation would not, we imagine, hold good in the case of the ordinary induction coil.

Although we recognize in dynamic induction a phenomenon, *sui generis*, in which the *direction* of a current of electricity is sufficient to determine certain electrical tensions in a separate conductor, we cannot fail to perceive a striking analogy between its effects and those which follow from static induction. Indeed, the action of the current, according to its direction, in producing certain tensions in the secondary wire, appears precisely similar to that which the conducting wire would possess in virtue of the distribution of its tensions, supposing it to be in uniform juxtaposition with the secondary wire. The following diagram will, therefore, in accordance with this analogy, apply equally to the *effects* of static and to those of dynamic induction.



Let A B represent a metallic conductor, united at A with the positive, and at B with the negative pole of the battery, the distribution of tensions along the wire being indicated by the diagonal dotted line, and measured at each extremity by the perpendiculars A *f* and B *i*. Again, let C and D represent portions of an insulated conductor, placed parallel with, and in contiguity to, the former, and separated at *e* by a certain amount of resistance. At the moment when A B assumes its conditions of tension as a conductor, the positive portion of the wire A *h* becomes, in relation to the conductor C, as one of the coatings of the Leyden condenser, charged from the positive pole of the battery, and of which C represents the opposite coating. The positive electricity of C is therefore liberated, a negative condition of tension being induced in this conductor, precisely as in the case of an ordinary Leyden arrangement; the outer coating of which, if insulated, furnishes sparks of positive electricity, when the inner coating is charged from the positive pole of a tension battery. Moreover, it is easy to perceive that the positive electricity liberated upon C will tend to escape from the extremity of this conductor, which is opposite to the perpendicular A *f*, and at which the negative induced tension is highest. Bearing in mind that a positive condition of tension is induced in the conductor D, or, to use the old expressions, that its positive electricity becomes dissimulated, and its negative electricity active, it is evident that a momentary current in an opposite direction to that in the primary conductor, will occur in the conductor C D, if its free extremities be brought into contact, and that if these extremities be approached to each other, the effect of a spark may become visible.

Here we have the induced current on making battery contact with the primary wire. So long as this contact is maintained, no further effect is produced in the secondary wire; but if the extremities A and B of the primary wire be disconnected from the battery, the primary and the secondary wires will both return to their normal condition of electrical equilibrium. We will, for the present, consider the effects of static induction, corresponding with those of dynamic induction, without any reference to the magneto-electric action upon which the action of the coil, on breaking the primary circuit, mainly depends. Supposing, for an instant, that the conductor A B regains its normal condition without the occurrence of any further dynamic effect in this wire, the momentary induced current in the secondary wire, C D, when its free extremities are brought into contact, will be exactly equal to that which occurs when battery contact is made with the primary, but will be in the *contrary direction*, *i. e.*, in the direction of the voltaic current originally traversing the primary wire. But, at the moment of disconnecting from the battery the extremities A B of the primary wire, a momentary dynamic effect takes place in this conductor, weakening the inductive effect in the secondary conductor. Thus, when battery contact is broken, and the extremities A B of the conductor are brought into proximity, a spark will pass between them; and, if these extremities be respectively connected to earth through a galvanometer, a current, *in the direction of the original battery current*, will be indicated upon the instruments. The spark which is seen when the primary circuit is broken is not, therefore, an effect of the discharge of electricity accumulated in a static form upon the wire,—as might be supposed from the conditions of electrical tension in this conductor—and also from the diminished effect of induction in the secondary wire, but an induced current, the same as that which has been discussed in our columns under the name of the "coil current." This fact, which was, we believe, first pointed out by Mr. F. C. Webb, is of some significance in regard to the action of the condenser attached to the induction coil. As in every other case where the conductor is disposed in the form of a coil, the induced current in the primary wire completely overpowers the current of discharge; and the latter, in regard to the secondary wire, is therefore inactive.

The intensity of the inductive effects in the secondary wire, or the rapidity with which the electricity accumulated in this conductor is liberated in a static form, is obviously dependent upon the instantaneous character of the inducing causes in the primary wire. The prolongation of the battery current by a current of induction in the same direction, diminishes, therefore, the effects of induction in the secondary wire when battery contact is broken. When a magneto-electric effect is produced by the insertion of a bundle of wires of soft iron into the axis of the coil, the induced current in the primary, as well as in the secondary wire, is augmented. The importance of the condenser, which accumulates on one of its coatings the electricity of the induced current, which otherwise would traverse the primary wire, may thus be appreciated.

The condenser is a simple or compound Leyden arrangement, the dielectric of which is of such a nature as to offer but little resistance to the inductive action on which the function of the condenser and its efficiency depend. A Leyden jar of stout glass, though it might be capable of receiving a high degree of charge from the electrical machine, would scarcely answer the purpose of a condenser for the induction coil, the electricity to be collected from the primary wire being of a *comparatively* low tension, and of considerable *quantity*. Paper, varnished or waxed, or oiled silk, appears to answer very well the purpose of a dielectric in the condenser for the induction coil. Whatever be the form of the condenser adopted, and its disposition for the sake of convenience, the principle of the Leyden jar must be adhered to in its construction, and applied in charging the opposite coatings of the arrangement. It is questionable whether the mode of attaching the condenser to each side of the "break" in the primary conductor, is the most efficient for the purpose in view. Nevertheless, this method has been found by Mr. Ladd,—in whose condenser the opposite coatings are connected respectively with each portion, *d* and *c*, of the contact breaker figured at p. 189, to produce excellent results. We shall shortly have occasion again to refer to the condenser for the induction coil, and to the nature of its operation.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 174.]

On consideration it seems possible that, although in the case of a conductor placed in the open air, the surface of the earth forms the only *solid* conducting surface opposed to it, and that this may

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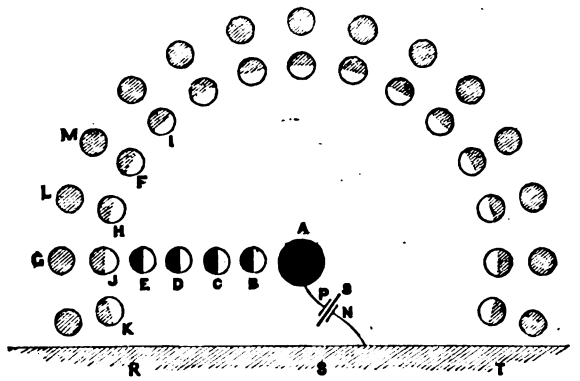
be considered practically as a boundless plane, and which consequently does not envelope the conductor in every direction, yet that, by virtue of the conductivity of the atmosphere (slight as that may be at times), such conditions exist as to produce, always at some distance from a charged conductor, a conducting boundary beyond which no action extends.

My suppositions on this point may perhaps be explained in the following manner:—

Suppose A (fig. 27) to represent a spherical conductor connected

Fig. 27.



to the positive pole of a source, S, the negative pole of which is connected to the earth, the surface of which is represented by R, S, T. Suppose this conductor, surrounded by innumerable small conductors, extending to an infinite distance, insulated from one another, and some of which are represented by the circles B, C, D, &c.

Now, as long as these remain perfectly insulated from one another, then, if we imagine it possible to charge the sphere A at every part of its surface, it must polarize all the conductors next to it, and these will again affect the next, and we arrive at what we have before alluded to, viz., interminable polarization, which I have suggested as impossible.

If, however, we suppose a hemispherical shell of particles, such as K J H F I &c. (fig. 27),* joined by conductors to the earth, and consequently to the negative pole of the source, we have at once a boundary of conducting matter beyond which no polarization can proceed, and which thus fulfils the conditions for an inductive circuit in every direction. The sphere A could thus become charged—by this hemispherical shell, and that portion of the surface of the earth which it includes, receiving the opposite charge.

The particles B, C, D, E, between the sphere and the shell, would be polarized, but the outer particle E would have its outer half, which by polarization is positive, opposed by the inner half of the particle J in a negative state. This negative state of the inner half of J is negative by *conduction* from the source, and consequently this particle is not polarized, its outer half being in the *normal* state. The outer half of J being normal, cannot therefore act on any of the particles exterior to it, such as G, I, M, all of which remain unaffected by the electrical disturbance within the shell. The degree of polarization of a single radiating line of particles will decrease inversely as the square of the distance from the centre of A.

I have here supposed one particular shell of particles to be joined by solid conductors to the earth, and if a single stratum or shell of air round the sphere contained more moisture than the air contained between that stratum and the sphere, this would of itself be only a modification of what I have described, and would fulfil all the conditions for an inductive circuit in every direction.

We have no right however, evidently, to suppose the air to contain more moisture in any particular place than in another.

* Figure 27 will serve well to illustrate the probable electrical state of the particles of the conductors and dielectric in the more ordinary case of charging a conductor in a room when one pole of the source is connected to earth.

The air is however in connection with the earth, and any shell or layer of particles communicates with the earth by innumerable conducting paths or lines of particles *exterior* to that shell.

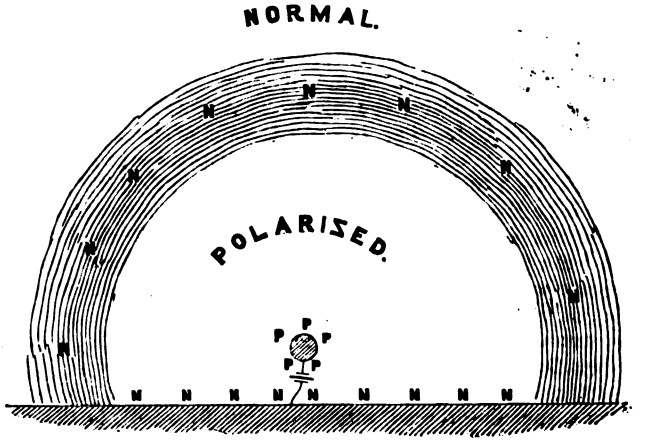
The exterior of any shell of air may be said, therefore, to be in connection with the pole of the source connected to the earth, the larger this shell is the less will be the conductive resistance between it and the pole of the source connected to earth. We have in such case the outer surface of a shell of air surrounding the sphere A in connection with one side of a source, and the inner surface (that bounding the solid sphere A), in perfect connection with the other side of the source.

Now let us look upon this shell as a conductor in the direction of its thickness, and divide it into innumerable shells of equal thickness; then, unless each shell yields up in a given time as much electricity to that next within it as it receives from the next without, accumulation must take place. But shells of equal thickness have a greater sectional area, for conduction in the direction of their thickness, exactly in proportion as the squares of their diameter are greater. The outer shells will therefore conduct a greater quantity in a given time than the inner ones, and accumulation will at *some* shell be at a maximum, thus forming a kind of outer surface for accumulation, opposing that of the sphere.

It is not to be supposed that such an absolute and abrupt change to the normal state can exist at any stratum or shell as when a perfect dielectric is bounded by a perfect conductor. The particles must be in a polarized state, though nearly normal as to the actual charge they contain, for some distance from the sphere A, but those more remote have an excess of negative electricity, although they may still be polarized, by being still included between the sphere A, and the particles beyond them, which are negatively charged, though to a still less degree. It can be conceived, however, that at some distance a whole layer of particles will be in a faintly negative state on one side, and normal on the other, the same as those of the particles K J H E I, &c., represented in fig. 27, though in a less degree.

The electrical state of the air that would ensue, according to this supposition, in the case of a sphere placed in the air above the earth is represented in fig. 28.

Fig. 28.



By similar suppositions it is easy to see how two spheres insulated from the earth could be charged to some extent on all parts of their surface from the two poles of a source when both are in the open air.

These views are, I am aware, theoretical and unsupported by experiment, and are only, therefore, advanced as mere suggestions.

Having given a rough outline of the most primary forms which the conditions for accumulation by inductive action can assume, I will proceed now to discuss how the degree of accumulation can be varied by an alteration in the elements of the different

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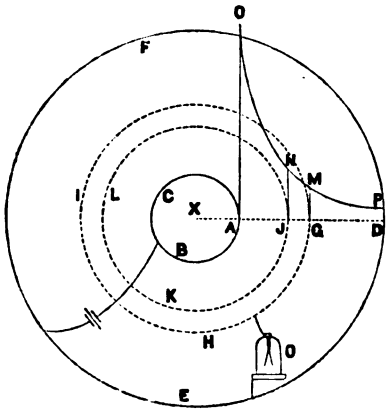
classes of conditions for induction which I have pointed out. Let A B C (fig. 29) represent, as before, a conductor in connection with the positive pole of a source of generation, the negative pole

Fig. 29.



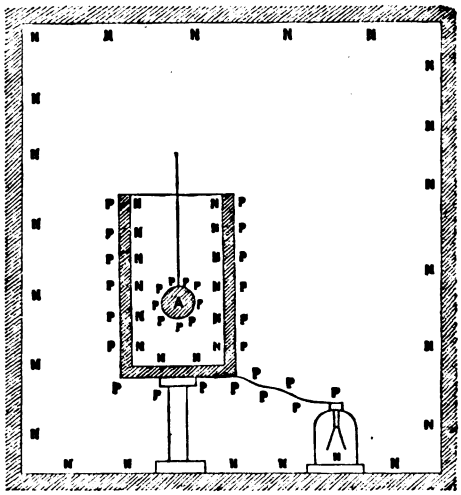
of which is connected to an outer conducting spherical surface, D E F. Then the two surfaces will receive equal charges respectively of positive and negative electricity, and since the surfaces are to one another as the square of their radii, the degree of accumulation or density will be inversely as the squares of their radii. Thus, if A O represent the density on A B C, the density on D E F will be D P, where $X D^2 : X A^2 :: A O : D P$. Suppose now the source be withdrawn, then the sphere A B C will retain the quantity with which it has become charged. Suppose now a spherical shell of conducting matter J K L, G H I concentric with A B C be inserted between A B C and D E F. This shell will then become, as we have before described, polarized, and the quantity of negative induced charge on its interior, J K L, will be exactly equal to the charge on A B C, whilst the positive induced charge on its exterior, G H I, will be also equal to A B C. The densities being represented by J N and G M, ordinates of the logarithmic curve O N M P. Now if A B C be touched to J K L, their two equal and opposite charges will neutralize one another, leaving the electrical state of the surface G H I unaltered. But this had a quantity of positive electricity exactly equal to the original charge on A B C, and therefore this surface is in the same state as if, supposing no polarization of the shell to have taken place, the charge of A B C had been wholly transposed to G H I. The electrical state of G H I will be exactly the same, therefore, whether that state be the result of its position between the two charged surfaces, A B C and F E D, or whether it be the result of the charge of A B C being transposed by conduction to its surface. If this is correct, the electroscope attached to the outside of the shell, G H I, should not alter its divergence when the sphere A B C is touched to the interior, J K L, of the intermediate shell.

The truth of this is shown by one of Professor Faraday's beautiful experiments.

A charged ball A (fig. 30), was introduced by means of an insulating suspending thread, into an insulated ice-pail, to the outside of which was attached an electroscope, E. When the ball was inserted, the electroscope diverged, and showed that the ice-pail was in a polarized state, exhibiting a certain electrical state on its surface of the same name as the charged ball itself. Whatever position the charged ball was placed in in the ice-pail (provided not too near the mouth of the pail), the same divergence of the electroscope continued, and finally, when the ball was touched to the pail no alteration in the divergence of the electroscope occurred, showing that although the ball had been completely discharged to the pail, and consequently that the pail must now have contained a charge exactly equal to the original charge of the ball, yet this charge was exactly equal to the induced charge which existed on the outside during the previously polar state of the pail.

I have since performed the experiments under more rigid conditions, the pail being covered so as to envelope the ball in every

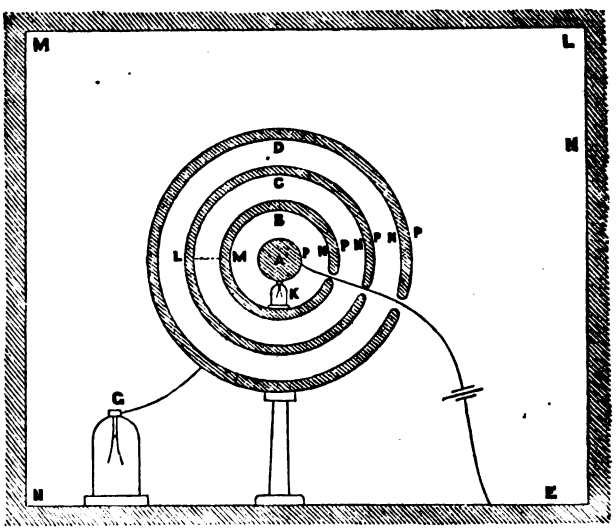
Fig. 30.



direction. In this case, therefore, the experiment is precisely similar to that represented in fig. 9.

Professor Faraday's experiments of this nature show some still more important points.* Suppose A (fig. 31) to be a sphere connected to one pole of a source, the other pole of which is connected to the outer opposing surface; and let A be surrounded by three concentric shells, B, C, and D, insulated from one another. Let D be connected to an electroscope G; then A will be in a position to become charged, at the same time causing the shells all to become polarized in the direction of their thickness. Supposing A positive, all the interiors of the shells will be negative, and all their exteriors positive. The outer opposing surface E L M N

Fig. 31.



being negative by conduction direct from the source. The electroscope G will therefore diverge. Let now the source be withdrawn, the electroscope will continue to diverge. If now B and C are joined together by a conductor L M, then the positive charge on the exterior of B will neutralize the negative charge on the interior of C, but no further effect will take place. Yet as B and C

* The experiments in question were performed with a series of ice-pails open at the top, but as the conditions attempted would be more rigidly fulfilled with spherical shells, the principles which the experiments establish will be more easily explained if we assume these more perfect conditions.

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are joined by a conductor, the polarization of the dielectric between them has now no longer to be effected by the two electrical forces on A and E L M N, which may be said to sustain whatever electrical disturbance occurs. If all the three shells were connected together, not the least difference would occur in the divergence of the electrometer.

From this we see that given equal quantities of opposite electricity polarize to such a degree any number of conductors which separate entirely these opposing forces, that the pairs of quantities of opposite electricity thus produced, however numerous, are always each equal to one another, and also to the primary charges causing the action. So that when any two opposing quantities are joined by a conductor, these neutralize one another without in the least disturbing the electrical state of the rest of the system. Thus the quantity on A being equal and opposite to that on the interior of B, if these be joined by a conductor they will recombine and neutralize one another without affecting the exterior of B, which again has a quantity equal to that originally existing on A, and if this is joined to C it will neutralize the charge on the interior of C, and if C be joined to D the quantity on the exterior of C will neutralize the charge on the interior of D, without affecting the charge on the exterior of D, which is exactly equal and opposite to the primary charge existing on E L M N.

The electrical state of the exterior of B is therefore the same, whether it be produced by the inductive action between A and ELMN through all the stratums of dielectric and conducting matter CD &c., or whether A be in direct conductive connection with B. Even if all the shells of conducting matter between D and A are removed, so that between A and D, dielectric only exist, the effect is the same on the electroscope attached to D; and finally, Professor Faraday shows, that if the nature of the dielectric be altered still no alteration in the exterior state of D results.

In the same manner it might be shown that if A, fig 31, were charged, as before, by a source having one pole connected to E L M N, and the source then removed, the electrical state of A to the interior of D would remain the same whether E L M N be connected to D, or D be connected to C, or C to B, or if (without forming any of these connections) C were removed entirely. The electroscope K attached to A would indicate no change in the electrical state within B.*

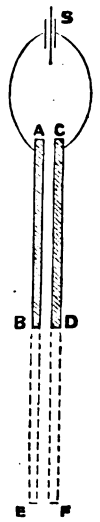
With *given quantities of opposite electricity once produced*, therefore, the total effect on the surfaces of an intermediate conductor entirely separating these opposite forces, is the same, whether the two forces have to act through several alternate shells of dielectric and conducting matter between the primary surfaces and the intermediate conductor, or whether it be wholly dielectric; or, in fact, whatever be the the state of the *inductive circuit*, the total effect on any intermediate surface is the same. In fact, the dielectric seems in such case to offer no resistance to the inductive action.

The *quantity that can be accumulated with a given source*, however, is a different matter, this depends, as will be seen, on the *resistance of the inductive circuit*.

Suppose after charging A (Fig. 31), whilst the shells B, C, and D were insulated from one another, we note the effect on the electroscope G attached to D. Let B, C, and D be now joined together by a conductor, and the source again applied, then it will be found the accumulation on D will be much greater, this being indicated by the increased divergence of the electroscope. The stratum of dielectric between A and D, through which the inductive action takes place, is diminished in thickness and replaced by conducting matter, and to this change we must attribute the favoured conditions for accumulation, for evidently everything else remains the same. We see, in fact, that a decrease in the thickness of the dielectrics forming part of the inductive circuit facilitates accumulation from a source. The dielectric, therefore, though essential to accumulation, offers a resistance to the inductive action in the same way that conductors, though essential to conduction, oppose in a greater or less degree conduction.

Let now A B and C D (fig. 32) represent two plate conductors (seen in section) opposed to one another a short distance, and so distant from the surrounding conductors, that all the inductive action may be assumed practically to take place directly between the two

Fig. 32.



plates. Let each be connected to the two poles of a source, S, they will thus receive each a certain charge, by direct induction between them, on their proximate surfaces. If now they be approached to half their former distance apart it will be found that the quantity accumulated will be doubled. If now, the plates, having been discharged, be separated to double the original distance, it will be found that the charges will only be half their original density.

The inductive resistance increases, therefore, directly as the distance between the plates.

Now if the plates be maintained the same distance apart, but doubled in surface to E, F, the same source can charge them all over to the same density as before their size was increased. The *total* quantity that can be accumulated with a given source therefore increases with the size of the plates. And the *resistance* to accumulation may be said, therefore, to decrease as the size of the plates is increased.

The inductive resistance between the two equal and parallel surfaces may be said, therefore, to be directly as the distance between them, and inversely as their surface, exposed to each other. If we take their distance apart as the length of the dielectric separating them, and the size of the plates as the sectional area of the dielectric, then

$$R = \frac{l}{S}$$

where R = Inductive resistance, l = length and S = sectional area of the dielectric.

This, it will be seen, is the same equation as that for resistance of conduction through solid prismatic conductors, easily deducible from the investigations of Professor Ohm, which will be described further on.

(To be continued.)

* There are some other points with regard to the distribution of electricity exemplified in these experiments of Professor Faraday, which will be noticed further on.

REPORT OF THE BRITISH AND IRISH MAGNETIC TELEGRAPH COMPANY (LIMITED).

In laying the Accounts of the past year before the Shareholders, the Directors are glad to be able to point to some increase in the receipts as compared with the previous year, notwithstanding the competition of the United Kingdom Company, since the 16th of November, for

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the traffic between London, Birmingham, Liverpool, and Manchester. The increased number of messages on these circuits has so far proved wholly inadequate to compensate for the reduction in rates, and experience shows that a charge of one shilling is here unremunerative.

The Directors cannot think that the public will derive any real benefit from a competition based upon a principle, which if erroneous (as they believe) cannot be lasting; but they have always been ready to consider and adopt such reductions in their charges, as would give the advantages of telegraphic communication on the lowest terms from which the Company could derive a fair remuneration for good and effective service.

In February last they made a spontaneous reduction of 33 per cent. on the traffic between Great Britain and nearly all their Irish Stations, and they have recently determined upon a general revision and modification of rates, which will, they hope, give satisfaction to the public and lead to an increase of business.

The expenses of maintenance are greater this year than last, which is partly owing to 382 miles of line being added, and partly to the unusual amount of damage caused on some of the lines by heavy storms in the first months of the year.

The increase in Salaries and Wages of the Commercial Department is £700, while the number of the Company's Stations has increased, and the messages transmitted have been nearly 90,000 more than in 1860.

The interest upon loans is increased, owing to non-receipt of dividend upon this Company's holding in the Submarine Company, with which this account has in previous years been credited; as well as to the expenditure of additional capital, partly for the construction of a new line between London and Beachy Head to join the Submarine Company's new Cable to Dieppe, and for the completion of the Leith and Dundee extensions, and partly for the construction of the Portpatrick and other Railway Telegraphs.

One of this Company's Irish Cables was found early in the spring to have been injured by the anchors of vessels, and it was considered desirable to repair it and relay it in a better and less exposed position. The cost of this, as will be observed in the annexed accounts, has been charged to revenue, and the cable is now in good condition.

Sir Charles T. Bright having resigned the appointment of Engineer to the Company, which he had held with great ability since its formation, the Directors have not thought it necessary to appoint a successor, but have retained his services as Consulting Engineer. Mr. E. B. Bright, as Secretary and General Manager, has now the chief control of all the departments of the Company.

The nett balance on the year's working amounts to £27,883 0s. 6d.; and after payment of the dividend for the year on the preference shares (£4,565 8s.), and for the half-year ending June 30th on the ordinary shares (£10,303 8s.), there remains a balance of £13,014 4s. 6d., out of which the Directors have declared a dividend for the half-year ending December 31st last at the rate of 4 per cent. per annum, leaving £2,710 16s. 6d. to be carried forward to the next half-year.

Some statements have appeared in the public prints relating to the length of this Company's line between Queenstown and London, and the number of repetitions consequently rendered necessary, the Directors gladly take this opportunity of stating that at present messages are only repeated twice, and often only once, between these points; and that if this special traffic were sufficient to justify the interference with the general business, there is no practical difficulty in avoiding even the trifling delay thus occasioned, and work ng between London and Queenstown, Galway, or Londonderry, without any break of circuit.

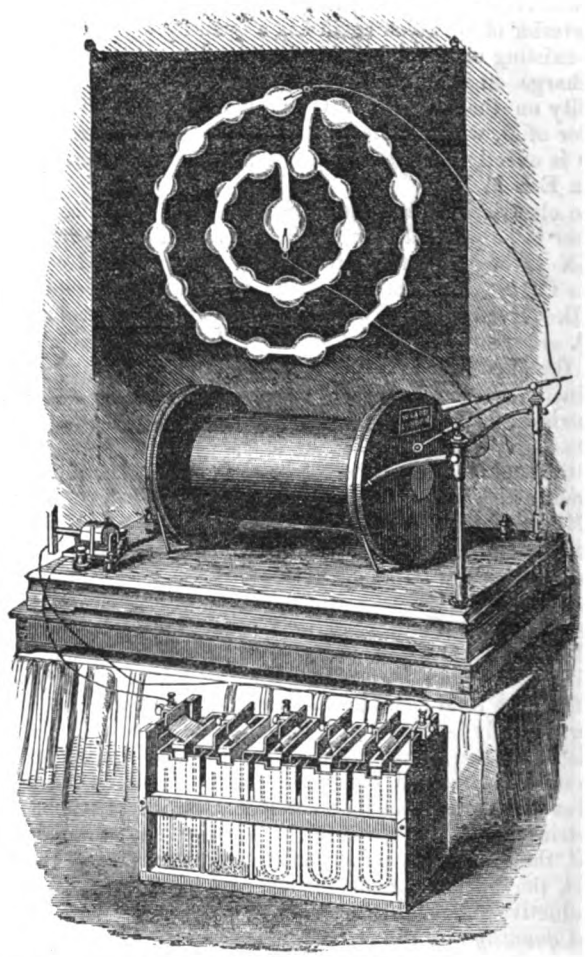
JOSEPH C. EWART, *Chairman.*
EDWARD B. BRIGHT, *Secretary.*

Liverpool, February 5th, 1862.

DEEP SEA SOUNDINGS.

Two lectures upon this interesting subject were lately delivered at the Orphan Working School, Haverstock Hill, by the Rev. F. W. Russell, M.A., F.R.A.S., F.S.A., Curate of Holy Trinity, Kentish Town. The reverend lecturer has devoted considerable attention to the subject of deep sea soundings, and is the inventor of a very ingenious apparatus himself, for the bringing up of ocean deposits from great depths. After enumerating the many failures which at first took place in the attempts to fathom the ocean, and after exhibiting the various instruments which had been employed for the purpose, without arriving at satisfactory results, such as Friend's and Massey's deep sea leads, and Johnson's pressure gauge, the reverend lecturer proceeded to explain the working of Brooke's, Dayman's, and the Bull-dog apparatus, as well as of that contrived by himself. By the aid of a large number of coloured diagrams, the audience were made acquainted with many of the curious forms of sponges, spicules, and foraminifera that had been brought up from great depths. The reverend lecturer also pointed out the necessity of a more intimate acquaintance with the nature and character of the bottom of the ocean for the successful submersion of telegraph cables. Several specimens of cables were exhibited, furnished by Mr. Owen Rowland, Electrician, and Experimentalist to the Government Enquiry, and which consisted of specimens contributed by the Gutta Percha Company, Messrs. Hall and Wells, Messrs. Silver and Co., Wray, Godefroy, Ratcliffe, and others. The lecturer concluded with an exhibition of Manby's apparatus for saving life in case of shipwreck, and gave an exceedingly interesting account of the rescue of Samuel Brock, of Great Yarmouth, after having been six hours and a half in the water.

THE IMPROVED INDUCTION COIL.



The above illustration represents the inductive discharge of one of the powerful coils constructed by Mr. Ladd, through one of Geissler's *vacua tubes* with 25 bulbs. The following description of the form of contact-breaker adopted in these instruments is extracted from Noad's description of the Induction Coil.

The contact-breaker merits especial notice, as it is to the improvements introduced into this part of the apparatus that the surprising effects of the coils of the present day are in a great measure to be ascribed. In Ruhmkorff's original instrument, the interruption of the battery current was, as we have seen, effected by the rising and falling of a small iron hammer; this, whilst it accomplished the general purpose of breaking and renewing battery current, set up no resistance, the hammer being raised as soon as the iron core had received sufficient magnetism to enable it to attract a very small piece of iron, whilst the falling of the hammer on the interruption of the current was in no way influenced by the degree of magnetization of the iron core. The contact-breaker is now constructed by Mr. Ladd, with the object of giving the operator the means of setting up a greater or less resistance

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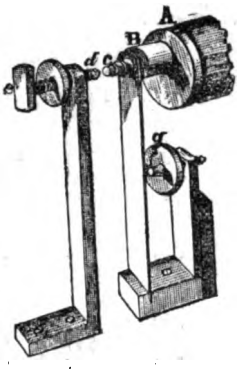
to the attractive force exerted by the magnetic iron core. This is accomplished by attaching the hammer to a stiff spring, placed vertically, as shown in Fig. 1, where A is the disc of iron capping one end

Fig. 1.



of the iron core; B, the iron hammer of the contact-breaker, surmounting a stiff spring attached to a brass stand screwed to the base-board of the instrument; *c* is a little projecting nipple, tipped with platinum; *d*, a corresponding little disc of platinum, soldered to the end of a screw, which passes through the top of a brass pillar, firmly screwed down to the base board; the distance between *d* and *c* can be regulated with the greatest nicety by the thumb-screw, *e*. Now, when *c* and *d* are in contact, and the commutator is turned on, the battery current in circulating round the primary coil, the fasciculus of iron wires becomes a more or less powerful magnet, according to the power of the battery; B is attracted to A, by which act *c* and *d* are separated; battery contact is hereby broken, and the effects of the induced current are obtained at the terminals of the secondary. But if the action of the contact-breaker ended here, it would be nothing more than Neel's hammer placed vertically; it will be seen, however, that by turning the screw *g*, the point *f* attached to its axis may be made to press with greater or less force on the spring supporting the hammer, thereby keeping *c* and *d* more or less firmly in contact, and necessitating a corresponding degree of magnetization of the fasciculus to part the platinum discs; when, however, this has been attained, contact with the battery is instantly broken, and the hammer is forced back with violence by the conjoint action of the spring and screw; *d* and *c* again come into contact, the iron core again becomes magnetic, A attracts B, and the battery current is stopped, *c* is again forced upon *d*, and so on. Now a degree of pressure may be exerted on the spring support of B by the screw *g* sufficiently great entirely to overcome the attractive force of A; under such circumstances the instrument is, of course, passive, but by gradually relaxing the tension at a certain point, the magnetic power of the core just overcomes the antagonistic force of the spring, and then it is that the most powerful inductive effects are obtained, evidently because then the fasciculus has received from the battery its maximum amount of magnetism, which it loses instantaneously by the interruption of the battery circuit, giving rise to a powerful wave of induced static electricity in the secondary coil. The influence exerted by the resistance thus set up to the rupture of battery contact on the strength of the induced current is far greater than could have been anticipated. The instrument we have been describing gives between the terminals of the secondary, when the screw *g* is entirely relaxed, thin thready sparks, about 1½ inch long, but when the spring is strained to the utmost, brilliant flashes of fire, upwards of 4 inches long, pass continuously. The control which this form of breaker gives to the operator while performing experiments in which considerable variations in the power of the induced current are required, renders it of great value.

REPORT OF THE RED SEA AND INDIA TELEGRAPH COMPANY.

February 17th, 1862.

It will be in the recollection of the shareholders that when the Second Ordinary General Meeting of the Company was held in February last Her Majesty's Government had deemed it necessary to defer the payment of the guaranteed interest until after the passing of an act to remove the doubts raised by the law officers of the Crown as to the unconditional nature of the contract between the Treasury and the Company.

The declaratory act confirming the original agreement was introduced by Her Majesty's Government at an early period of the session, and, after having been referred to a select committee, was finally passed on the 22nd of March, when the interest was immediately paid.

This question having been settled, the directors lost no time in bringing the state of the line, and the company's position in connection with it, under the notice of the Government, and repeatedly urged the necessity of immediate action, with a view to carrying out the important work for which the company had been formed.

The Government were, however, indisposed to take upon themselves the responsibility of proceeding with the undertaking, and matters remained *in statu quo* till shortly after the payment of the August dividend, when a proposal was made to the Treasury by Sir Macdonald Stephenson, who undertook to form a company for the purpose of taking measures to restore the communication, on condition of receiving from the Government the lines and property of the Red Sea India Telegraph Company free of charge.

The Government adopted the suggestion, and negotiations were in consequence commenced, which resulted in a proposition made by the Treasury to the board, in a letter dated 15th October, 1861, in which the Government undertook—

1. To divest the existing company of all further responsibility in respect to the affairs of the Red Sea and Indian telegraph, with a view to transferring the entire concern to the hands of a new company, on suitable terms and conditions, should any such company be formed with an amount of capital sufficient to justify a reasonable hope of the success of its object.

2. To convert the present guarantee into a Government annuity of like amount, payable at the Bank of England, as is the case of other Government annuities.

It would follow from this conversion that all expenses of disbursements would be defrayed by the Government.

3. To reserve power to the Government to redeem this annuity at any time hereafter, on payment of a capital sum in proportion to the unexpired period which the annuity may then have to run.

This proposal was submitted to the shareholders at a special general meeting held on the 5th of November last, when the terms were accepted, and the following resolutions were unanimously passed:—

Resolved,—"That the proposition contained in the letter addressed by the Secretary of the Treasury to the Directors of the Red Sea and India Telegraph Company, on the 15th October last, be, and is hereby, accepted, on the understanding that it be made clear in the arrangement with the Government that the intention of clause 3 in the proposition is, that in the event of the Government deciding to redeem the annuity, they shall pay a capital sum which will be sufficient to purchase a Government annuity of £4 10s. per annum on each £100 of the stock or capital of the company, for the unexpired residue of the term."

Resolved,—"That the directors be, and they are hereby, authorized to take all necessary measures for carrying this arrangement into effect."

The correspondence set forth in Appendix No. 1, has since taken place between the board and the Lords Commissioners of Her Majesty's Treasury, from which the shareholders will see that the Government adopted the interpretation of the 3rd clause put upon it by the meeting.

The shareholders will also see, from the correspondence set forth in Appendix No. 2, that the new company having fulfilled the terms of their engagement with the Government, by the subscription of two thirds of their capital, and the despatch of a steamer to the Red Sea with 200 miles of new cable on board, made application to the Treasury in the month of December last for the stipulated transfer of the line and property of the Red Sea and Indian Telegraph Company, and that the arrangement for the transfer of the line and property of the company has been carried out, subject to the necessary Parliamentary powers for the creation of the annuity, and that the new company have undertaken to relieve this company from all further liability as from the 1st of February instant.

The directors cannot close this report without congratulating the shareholders upon the satisfactory termination of their protracted negotiations with the Government, in an arrangement which, while it converts the guarantee into a Government annuity of like amount, admitting of no doubt or question, also affords a fair prospect of bringing to a successful result the great national undertaking of the establishment of telegraphic communication with India.

The accounts for the past year are laid before the meeting.

As it is necessary to retain the machinery of the company until the company is finally wound up, the following directors retire by rota-

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tion, in compliance with the requirements of the act of Parliament, and offer themselves for re-election :—

Mr. John Clark Marshman.
Sir Macdonald Stephenson.
Mr. Alexander Wilson.

Mr. Alexander Mackenzie, one of the auditors, also retires, and offers himself for re-election. By order of the Board.

JOHN C. MARSHMAN, Chairman.
C. L. PEEL, Secretary.

The Student.

All the metals are classed generally under the head of *electro-positives;* being opposite in their electrical and consequently in their chemical characters to the bodies which are termed electro-negatives, such as oxygen, chlorine, and the acids. If the reader will turn to p. 152 he will find this classification referred to very intelligibly and concisely by a correspondent to this journal.

In regard to each other, however, two metals may be said to stand in the relation of electro-positive and electro-negative. Thus copper may be said to be electro-negative to zinc; the affinity of the latter metal for oxygen being greater than that of copper.

As in the voltaic battery we require two bodies standing in this relation to each other, i. e., one which is chemically acted upon by the negative exciting fluid, and another which is indifferent to it; it may be useful to arrange some of the metals in a series according to their electrical character, commencing with those which are most electro-positive. Thus we have :—

Potassium	Copper
Sodium	Mercury
Zinc	Silver
Iron	Gold
Tin	Platinum
Lead	

It should here be stated that, although the metal iron stands somewhat high in the scale as an electro-positive body, it may, under certain circumstances, as when immersed in strong nitric acid or combined with a large proportion of carbon, become a most perfect electro-negative in regard to other easily oxidizable metals. Plumbago, which is a compound of carbon and iron, and charcoal or gas-carbon are electro-negative even in regard to platinum.

It will be remembered that the hydrogen gas from the decomposed exciting fluid is evolved from the negative element of the voltaic couple. An important condition in regard to the efficiency of the battery is the removal of this hydrogen, which collects on the surface of the negative element, thereby impeding its action. For this purpose a fluid is generally employed, which readily yields up a portion of its oxygen to combine with the hydrogen, forming water,—such as nitric acid, a solution of bichromate of potash, or a metallic salt the metal of which is easily reduced from its condition as oxide. Of these, nitric acid appears to be the most efficient for the purpose in view, but the evolution from it of nitrous fumes when the battery is in action, renders it objectionable in practice. Occasionally a solid which readily yields a portion of its oxygen is employed, in admixture with water, for the "exciting fluid" of the negative element,—such as the peroxides of manganese and of lead. In Smee's battery the evolution of hydrogen from the negative is facilitated by the presence of an infinity of minute points of platinum upon the silver plate. The Smee's arrangement has therefore been called the *chemico-mechanical* battery.

The Grove battery, an intensely powerful arrangement, consists of a positive plate or cylinder of amalgamated zinc* immersed in dilute sulphuric acid, and of a negative element of platinum first immersed in nitric acid. A porous jar or diaphragm is therefore necessary in this as in most other arrangements. In the Bunsen battery the negative element is of graphite or gas carbon, which is at least equal in efficacy to the platinum strip. The objections to the extensive use of the harder forms of carbon for the negative element of voltaic arrangement are the extreme difficulty of cutting and working them, and of making a permanent metallic connection. In gas carbon, a material of the greatest cheapness, we have the best negative element hitherto discovered, and it is therefore greatly to be desired that some means may be found of cheaply converting into battery plates a portion of the large "clinkers" always to be found at the gas-works.

* Zinc plates are amalgamated by dipping in dilute sulphuric acid, and rubbing a small portion of mercury over the surface by means of a cork or piece of cloth.

TABLE OF THE SIZE, WEIGHT, LENGTH, AND STRENGTH OF IRON WIRE.

As given by Messrs. Rylands Brothers, Warrington.

Wire Guage.	Diameter.	Weight of 100 Yards.	Length of 1 B'dle.	Length of 1 Cwt.	Direct Strain. Area of Section.	Direct Strain. Breaking Weight.	Wire Guage.
No.	*In.*	*lbs.*	*Yards.*	*Yards.*	*Sq. inch.*	*lbs.*	*No.*
00	0·380	110·32	57	102	0·113	9040	00
0	0·340	88·31	71	127	0·091	7280	0
1	0·300	68·75	91	162	0·071	5650	1
2	0·280	59·90	105	187	0·062	4930	2
3	0·260	51·65	121	215	0·053	4250	3
4	0·240	44·00	143	255	0·045	3620	4
5	0·220	37·00	170	303	0·038	3040	5
6	0·200	30·56	203	361	0·031	2510	6
7	0·185	26·15	239	428	0·0265	2220	7
8	0.170	22·10	286	509	0·023	1840	8
9	0·155	18·36	342	609	0·0195	1560	9
10	0·140	14·97	420	747	0·016	1280	10
11	0·125	11·95	529	937	0·0125	1000	11
12	0·110	9·24	700	1244	0·010	800	12
13	0·095	7·05	893	1589	0·0071	568	13
14	0·085	5·51	1142	2031	0·0057	456	14
15	0·075	4·29	1468	2608	0·0044	352	15
16	0·065	3·22	1954	3473	0·0033	264	16
17	0·057	2·48	2540	4515	0·0026	208	17
18	0·050	1·91	3150	5600	0·0020	160	18
19	0·045	1·55	4085	7246	0·0016	128	19
20	0·040	1·22	4912	9168	0·0013	104	20
21	0·035	0·94	6416	11980	0·0010	80	21
22	0·030	0·69	8736	16300	0·0007	56	22

Sizes expressed in Fractions of an Inch.

$\frac{3}{8}$ in. = No. 00 | $\frac{5}{16}$ in. = No. 1 | $\frac{3}{16}$ in. = No. 7 | $\frac{1}{12}$ in. = No. 14
$\frac{1}{8}$ in. = No. 0 | $\frac{1}{4}$ in. = No. 3½ | $\frac{1}{8}$ in. = No. 11 | $\frac{1}{16}$ in. = No. 16

Colonial and Foreign Telegraphy.

VICTORIA.

The notice of the Committee of Ways and Means having been directed to the circumstance that telegrams issued from the telegraph office here show the time at which they are received only, but not the time when they are given in to the office of the place whence they come, the committee, thinking this additional information important, applied to the superintendent on the subject, and have received from him the following reply :—

"*Observatory and Telegraph Department,*
"*Chief Office, Adelaide, Oct.* 30, 1861.

"Dear Sir.—With reference to your letter of the 18th instant, calling my attention to the desirability of inserting on each message issued for delivery the time of its being first handed in, as well as the time of its transmission at present given, I beg to state that it will afford me great pleasure to carry out the views of the Chamber of Commerce as far as they are practicable, and will accordingly issue instructions to the several offices in this colony to transmit in future with each message the time of its being received from the 'sender.'

"On the Port line, however, on which the number of messages is very great, it would rather seriously retard business to give the time in each case; and as I have no reason to believe that any improper or unavoidable delays occur in that, or indeed on any of the lines *wholly* under my control, I do not think the advantage to be gained by adopting the arrangement recommended would, in the case of messages between Adelaide and the Port, compensate for the additional time occupied. In all important cases the time could be inserted in the body of the message, frequently without exceeding the 20 words allowed, or at most by an increased payment of 3d.

"On the intercolonial lines I should be glad to see the suggestion of the Chamber of Commerce adopted, and believe it would be beneficial to the service. I could, however, only do so with the concurrence of the authorities in the other colonies. I will write and urge its consideration.

"The Chamber will perceive that we now publish the Melbourne shipping.—I am, &c., Charles Todd,

"Observer and Superintendent of Telegraphs, S. A."

From the South Australian Register, Nov. 26, 1861.

NEW SOUTH WALES.

The estimates for further telegraphic extensions, proposed by Govern-

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ment, have been passed by the Assembly, and should the session be brought to a close by the end of the year, the new lines will be proceeded with early in 1862. The longest of the proposed extensions will be that to the Burrangong gold-fields, which will probably be carried from Orange through the Lachlan, should the diggings at the latter place continue to be the centre of a large population. A line is also to be taken from Tenterfield, the most northerly telegraph station in this colony, across to Grafton, which will bring the Clarence River district into communication with Sydney. The southern ports of Wollongong and Kiama are to have telegraphic wires, which will probably branch from the Southern line, near Douglass Park, about twelve miles beyond Campbelltown. The other extensions will consist merely in stretching second wires upon the present posts, from Scone to Muswellbrook, and from Newcastle to Singleton.

All the telegraphic extensions carried out under the votes of last session are finished and in use. The last of these was the line from Goulburn to Braidwood, which was opened by Mr. Cracknell three weeks since.

During a recent debate in the Assembly, when the estimates for telegraphs were under discussion, Mr. Arnold stated that the lines throughout the colony paid an interest of 5 per cent. on the outlay, besides the working expenses. Two years since, when the only telegraphic line was that to Melbourne, the nett return on its working was sixteen and a half per cent. The lines recently constructed have consequently diminished the remunerativeness of the establishment; they have, however, in other respects, conferred great advantages on the community. The best paying stations (excluding Sydney) were stated to have been relatively, Newcastle, Maitland, Bathurst, Mudgee, Yass, Goulburn, Redfern, Campelltown, Morpeth, and Sofala—there having been on the other stations a loss which was made up from the general profits.—*The Sydney Morning Herald, Dec.* 21, 1861.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do B. 7 per cent. till 1862	all	18 to 20	———
20	Do. C. „ „	all	9 to 11	———
Stock	Electric Telegraph . .	100	96 to 99 xd	97½ xd
20	Red Sea and India Telegraph	all	19¼ to 19¾	———
1	Submarine Telegraph, scrip.	all	3/8 to ½	———
1	Do. registered . . .	all	3/8 to ½	———
10	Do. „ . . .	all	4 to 6	———
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	———
	Mediterranean Extension Tel.	all	4 to 5	———

Law Intelligence.

COURT OF EXCHEQUER, FEBRUARY 17TH, 1862.

WHEATSTONE AND OTHERS *v.* WILDE—ELECTRIC TELEGRAPHS.

THIS important case, which had, after two days argument in the month of December last, been postponed until the above date, came before the court.

The large collection of instruments displayed upon the table, and the declaration of the counsel for the defendant that the plaintiff's patent included some 15 other already patented inventions, seemed to have terrified both judge, counsel, and jury. We append the report as it appeared in the public papers, reserving our comments for the present:—

Mr. Groves, Mr. Hindmarsh, and another learned gentleman were counsel for the plaintiffs; Mr. Bovill, Mr. Manisty, and Mr. Webster were counsel for the defendant.

This was an action for the infringement of two patents taken out by Professor Wheatstone, for certain improvements in electric telegraph apparatus. It was set down for the last sittings, and having been tried two days, was adjourned, and was specially appointed for to-day. On the case being called on,

Mr. Baron Wilde said it would be better, if possible, that it should be referred.

After a long conversation between the learned counsel,

Mr. Bovill suggested that the learned judge should meet Mr. Grove and himself in his private room, which his lordship assented, and on their return into court,

Mr. Grove said a reference had been agreed to on terms.

Mr. Baron Wilde said that when he suggested that the cause should be referred he had not done so with respect to the probable length of the trial, or the impossibility of trying it, but the extreme complication of the instruments, as well as the peculiarity of the subject, which was highly scientific, rendered it, in his judgment, utterly impossible to try it before a jury.

The jury were then discharged without coming to a verdict.

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

DURABILITY OF THE INSULATORS.

To the Editor of THE ELECTRICIAN.

SIR,—Appended to a former letter of mine (ELECTRICIAN, January 31st), is a note, wherein you inform me that I have not proved the porosity of gutta percha; but I beg to submit most deferentially whether it would be considered imperatively necessary to prove that it is broad day-light at noon? That which is patent to every one, I take it requires no proof, especially in matters that come within range of our unassisted optics; and then, what you remark, that "the fact of its porosity is generally admitted," renders the production of proof superfluous, even if it were not self-evident to the most superficial observer.

The fact of its porosity, then, being admitted, and its proficiency as an envelope in securing the central position of the conductor dubious, we next come to consider the relative capacities of durability possessed by the two materials. And here we may as well anticipate the objection so frequently cast in the teeth of the supporters of rubber, viz., "treacle" and "decomposition." It is better to meet the charge manfully, and while regretting the circumstance, admit every fact that has been proved adverse to your cherished notions and well grounded conclusions; confident that you possess the power to turn even a disastrous accident to the support of facts which you know to be as durable as truth itself, than by a weak vaccilation, to shirk the question, or ignore it altogether. We have no wish to refute the charge or prove it false; be it our object to refute the false conclusions deduced therefrom. There are two ways of satisfactorily accounting for the decomposition of the wires in question, either of which would be productive of the consequences that ensued.

It is possible to deteriorate an inherently good article by its admixture with an inferior commodity, either for the purpose of cheapness, or from some erroneous notion that the admixture will be beneficial. And 2ndly a first class commodity for a given purpose may be rendered inefficient, and its eminent qualities nugatory, by inexperienced application in the construction or manufacture; or from want of a thorough and intimate knowledge of the essential elements of the material to be operated upon. Hence an experienced builder may erect, from the best materials, an edifice as ephemeral as his own life; while a skillful workman shall raise from the same materials a superstructure capable of withstanding the blasts of centuries.

And as to the former, the adulteration which enters into every imaginable article which makes up the infinitely multiplied requirements of modern society is too notorious to need comment. When you can eat bread without plaister of Paris and old bones, drink your coffee free from potters clay and sawdust, wear woollen hose minus a thread of cotton, and bedeck yourself with genuine jewels set in pure gold instead of lacquered brass, then you may turn up the white of your eyes in astonishment that deleterious compounds should have entered into the manufacture of india rubber.

Now I dare fearlessly assert that the decomposition of india rubber as an insulator, in any and every case, is to be attributed to one of the above causes.

I should imagine we are all agreed that rubber, to be effectively durable, should be pure, just as much as we admit that the engine beam of the New Hartley Pit should have been constructed of malleable, instead of cast iron. For important purposes the material used cannot be too pure and free from extraneous matter.

Under ordinary circumstances, and up to a certain temperature, probably the durability of gutta percha may be equal to caoutchouc; certain it is that the latter, when pure, is capable of a comparative unlimited duration. It may be questioned indeed if it, like most other substances, bears within itself the elements of its own decay; there is certainly no appearance of the kind, while at the same time the outward circumstances that might prove fatal to its durable qualities are exceedingly limited, and the occasions for bringing them into contact are still more so.

I have seen rubber more than half the age of the present century, and it is as good now as the best offered in the market, and I doubt not that the fag end of the century will find it with all its perfect qualities still unimpaired.

I have also seen caoutchouc insulated wires subjected to the most severe tests that electrical engineers could devise, issuing from the same unscathed, and all their eminent qualities remaining intact.

I could speak of the same description of wires having been for upwards of two years submerged in sea water, with but a slight protective tape covering, retaining their insulating properties perfect, and their electrical condition uninjured.

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Can anything be more conclusive and satisfactory as to the durability of caoutchouc?

But it is in high temperatures that the superior insulating properties of india rubber more particularly appear. Beyond 75° or 80° Fah. gutta percha is practically useless; consequently it must ever be at a discount between the tropics, if not for some considerable distance north and south of Cancer and Capricorn; and the electric spark will flash through the length and breadth of our vast Indian Empire by means of caoutchouc insulation, if efficiency, permanence, durability, and true economy, are to be the order of the day. It is gratifying to know that the authorities entrusted with telegraph matters in India take the same view of the case, and have resolved upon the adoption of india rubber. "Pure para rubber may be subjected to a temperature of 212° with impunity." Such is the testimony of a gentleman not overweeningly fond of it.

By experiment, gutta percha coatings are completely destroyed when subjected to a certain temperature for a given time; while india rubber will stand the test of a much higher temperature and remain uninjured. But the experimental tables of the Government Report are eloquent upon this subject, and prove incontestably that for durability gutta percha is "nowhere" in comparison with caoutchouc.

What has been said of the preference which must necessarily be given to caoutchouc in the torrid zone, applies also with equal force to the all important subject of the core for submarine cables. But this I must defer dwelling upon now; at a future time I may trouble you with a few desultory lines upon the subject. But one cannot but acknowledge how providentially it happens, that at a time when telegraphy is making such gigantic strides, and the establishment of a complete net-work of wires in order to connect Great Britain and her dependencies, in every part of the globe, is esteemed an absolute necessity, but which has been retarded by past failures; that those defects have led to the introduction of an insulating medium, possessing inherently all those essential qualities which fit it for all climes, and all circumstances; really this ought to be matter for rejoicing instead of envy, bickering, strife, and an inglorious rivalry.

Momus.

February 17, 1862.

ELECTRO MAGNETS.

To the Editor of The Electrician.

Sir,—You or any of your readers would greatly oblige by informing me of the best proportion of an electro magnet capable of sustaining from 3 to 4 tons, or even 5 tons. I wish to know the length and guage of the wire and the iron core, and the requisite amount of battery power.—Yours, &c.

W. Johnson.

To the Editor of The Electrician.

Sir,—In my letter appearing in your last there are three errors. In the eighth line from the bottom read "iron wire" for "iron zinc;" the twelfth line, for "galvanometer" read "caloriometer;" and the nineteenth line from the top the word "acid" is omitted after "free." As you have been kind enough to give insertion to this letter, I have taken the liberty of addressing you again. I promised to give a description of a coil machine, made from iron wire, covered with cotton. Whether there is any novelty in this I leave to the judgment of more experienced amateurs; suffice it to say that it is more economical than copper wire, and certainly gives shocks of equal intensity, and more so than the same amount of money paid for copper covered wire. Before describing this, I will state for the benefit of amateurs who would prefer using copper wire, that it may be used without being bought ready covered (and that will save nearly half the expense), by winding up the reel, side by side with the copper wire, string of the same diameter as the copper wire, this will perfectly insulate them from each other. After the first layer is on, a coat of shellac varnish is laid on, and over this is wound strips of paper to cover the whole length of the bobbin; the same may be done with the secondary wire, which if it takes longer than the usual method has the advantage of being cheaper, and the wire is certainly well insulated with very little trouble. The one I am about to describe is made with uncovered copper wire for the primary, insulated in the manner described above, it is wound on a piece of gas tubing, with a slit running right through the pipe, so that the pipe is dissevered right through from end to end; this is important, otherwise the bundle of iron wires inserted in the bore will have no effect in increasing the power of the shocks. Two circular pieces of wood are fixed on the ends of the pipe, the copper wire is not laid on in one length, but in three separate coils, so that there are three short channels for the primary current to traverse instead of one long wire, and this gives more magnetism to the core. The amount of copper wire is one pound of good sized bell wire, and very bright. After the last layer is on (of the primary wire), I cover the whole with thin gutta percha. For the secondary wire I use covered iron wire, of No. 18 guage, which as iron wire has nine or ten times the resistance of copper, I make up for by increasing the size of the secondary wire, the amount of iron wire is about two pounds, and each layer insulated by shellac or resin, dissolved in naptha, and again covered over with paper and another layer of varnish. A coil of this description can be made for about five shillings, and with the battery as described in my last, will give sufficient powerful shocks to amuse and instruct any amateur or his friends for a considerable time; the contact breaker is arranged on the usual principle. Coils can be made with [illegible] only, by allowing 9 strands of 18 guage wire for one length of [illegible], so that if I had used iron wire instead of copper for the primary, I should have had 27 layers of iron wire instead of 3 of copper, but this would not be found correct in practice, as a much less quantity of iron wire would suffice for giving shocks with the same sized wire used singly for the secondary wire. If you think there is any novelty in the above I shall deem it a favour if you have space for its insertion, at the same time as I only write for the benefit of amateurs like myself, I shall be glad to give any information I may possess to others about constructing their machines, both in frictional or voltaic electricity. If I am not trespassing on your valuable space too much, I shall in a future letter give a description of some other and less complicated battery, and *one* which will give very violent shocks for about one shilling each.—I am, sir, yours respectfully,

J. Cook.

P.S.—Can you give a description of the condenser I alluded to in my last.

Miscellanea.

The mixture of sulphuric acid with water, which acts most powerfully upon the metal zinc, was ascertained by De la Rive to be 33 parts of the concentrated acid to 100 of water.

The quantity of hydrogen gas disengaged by the action of dilute sulphuric acid upon distilled zinc, is only $\frac{1}{10}$ of that evolved, during the same space of time, when the manufactured zinc of commerce is dissolved in the acid. This fact enables us to estimate the amount of waste in local voltaic action between the zinc and its various impurities, which occurs when unamalgamated zinc of commerce is exposed to the action of a free acid in a voltaic arrangement.

Mr. W. O'S. Brooke (India), "Apparatus for Suspending and Insulating Electric Telegraph Wires.—For the purpose of this invention, in order that electric telegraph wires may be insulated where they are supported, the apparatus is formed in the following manner:—An inverted cup or hollow vessel—by preference of cast iron, and of a rectangular form—is used, the upper end of which is closed, and has formed on it a recess suitable for receiving and having a wire fixed therein by solder or by clamps of hardened india-rubber, prepared wood, or other material. The edges of the sides at their lower ends are turned up into a trough or gutter-like form; on the interior of this inverted cup or hollow vessel is fixed another hollow inverted cup or vessel, composed of the hard compound produced by combining india rubber and sulphur, and submitting the same to high temperatures. The inner cup or hollow vessel is of like section to the outer cup or vessel above mentioned, but of less dimensions, so as to leave a space in all directions between the inner and outer cups or hollow vessels, and such space is filled up with melted sulphur. This apparatus is placed on an upright pin or support, by preference of wrought iron, though other material may be used, and such pin or projection is of like section to the interior of the inner inverted cup or vessel, but of different dimensions, so as to leave a space in all directions between the pin or support and the interior of the cup or vessel which is filled with melted sulphur. The pin or support is carried by a bracket or post, or other suitable means.—*Patent, dated 17th July*, 1861.

To Correspondents.

We have on several occasions directed the attention of our readers to meteorological changes as influenced by electro and magnetic phenomena, also the attention of electricians and telegraphists, to the effect of the various electric and magnetic disturbances upon aerial and submarine lines; and upon those subjects communications have appeared from time to time in our columns. Those subscribers to our journal who are now temporarily engaged, or permanently resident, in various distant parts of Europe, Asia, or Africa, are particularly invited to communicate the results of their observations.

W. Johnson.—The Electrician will be published in volumes complete, with Index, &c. You will in due time receive your Index, so you can bind up your weekly numbers in volumes.

H. (Haverford West) writes:—"Can you or any of your readers inform me which is the best circulating library in London to procure books on electrical and scientific matters?"

We shall insert, for the future, notice of all important patents taken out for electrical discoveries or inventions.

J. Cook.—Fizeau's *condenser* is a strip of oiled silk, on each side of which is attached a narrower strip of metallic foil, so as to leave a margin of oiled silk. When placed between two similar strips of oiled silk or other insulating material, the condenser may be folded up and inserted in the base-board of the coil machine. For the sake of convenience in connecting the two coatings of condenser, one of the metallic strips is generally allowed to project a little beyond one end of the covering; the other metallic strip similarly projecting at the other extremity. The coatings are placed in the circuit of the primary wire by connecting them respectively with the separate portions of the contact breaker. Other forms of the Leyden conductor may be adopted, and the method of connecting the opposite coatings may be varied.

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The Electrician.

Vol. I. No. 17.—February 28, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 183.]

51. The experiments which by this time the student will have made with the electrical machine and other apparatus, must have taught him, among other things, the three following elementary facts. 1st. That the condition of static rest in which electricity is naturally united to common matter is susceptible of becoming disturbed. 2dly. That electricity, when its natural distribution has been deranged, may be accumulated in some kinds of matter by insulating them, or surrounding them, by other kinds. And 3rdly. That, when not prevented by insulation from so doing, electricity has the power of dispersing itself among conducting substances. We shall not get at the causation of the two former of these facts until we have mastered the theory of the last of the three, and know precisely *why* electrical charges do not remain on conductors exactly where they are first placed; we shall therefore at once set about enquiring into the mechanical principles involved in the distribution of electrical charges.

52. In the early days of the science people were satisfied by imputing to electricity the character of a fluid, and to believe that electrical charges flowed over all the conducting surfaces in communication with any one of them on which it happened to be placed; we now know that to be untrue, inasmuch as electrical charges avoid some conducting surfaces to the preferment of others; and if it were true, we could not be content without knowing something more about the nature of electrical fluidity. All that we have learned of other things flowing makes us refer their distribution to the force of gravitation, but most certainly the distribution of electricity cannot be ascribed to that cause.

53. The old theorists made an attempt on mechanical principles to explain the distribution of electrical charges by teaching that plus electricity, while being attracted by every part of the mass of common matter in which it was located, was dispersed by a superabounding force of repulsion acting among its own particles, which sent it to the extreme parts of bodies, where, encountering some unknown kind of atmospheric pressure, it fell into a sort of equilibrium. That conception of causation never satisfied any one, and even if it had done so we should have to find another in place of it, because our theory has neither an indefinite amount of electrical attraction, nor any repulsive force, both of which would be required. The student will not wish us to go further into detail concerning a doctrine, which, after all, every one must continue to look upon as a fiction.

54. We can turn to the new principles for a better guidance, tracing them, as we have hitherto done, step by step. We have seen experimentally, by bringing an insulated conducting ball in its natural state into momentary contact with another charged with plus electricity, that the charge distributed itself between the two. (Expts. 12, 13, 14.) Our first step will be to show that electrical charge under such circumstances resides wholly upon the external surfaces of bodies even if they be hollow.

Exp. 15. Remove from its insulating support one of the spherical conductors (35), and put in its place a small circular table of metal, or wood covered with tin-foil. On the table thus insulated stand a deep metallic vessel, such for instance as a small drinking cup, and communicate to it an electrical charge by momentarily connecting any part of it by means of a discharging rod (34), with the positive conductor of a revolving machine. Touch the vessel, which will thus have become charged, with a small brass ball cemented to the end of a long stick of sealing-wax, or varnished glass, introducing the ball within the cup down to its bottom; on removing the ball, without allowing it to touch the sides of the vessel any where contiguous to its top edge, it will be found entirely free from charge, which may be known by its not attracting a thread of cotton suspended vertically near to it. Then with the same insulated ball touch the outside of the cup, or the table on which it rests; on again making trial by the thread the ball will be found charged with electricity. So far therefore as we can learn from this experiment we have reason to believe that the electrical charge of the hollow vessel resided upon its external parts.

55. We may prove in another way that electrical charge resides wholly on the surfaces of conductors when they are surrounded by the atmosphere. For convenience sake the three moveable conductors used in Expts. 12, 13, 14, were made solid; but if either of them had been constructed of the thinnest metallic sheet, or of wood turned hollow, it would have divided the electrical charge equally with either of the solid spheres; and this is true of conductors of like figure and dimensions, even though they may much differ from one another in the materials of which they are made. All this the student can practically assure himself of by making the suitable experiments, and examining their results in the way already indicated, and with which we hope he is by this time tolerably familiar. It may perhaps be satisfactory to add that this particular fact is one of the oldest on record; but it certainly is one which, under the old doctrines, has proved the most unaccountable.

56. Further back we remarked that the severest proof that can be demanded of the truth of a system is, in our estimation, the general consistency of all its parts, judged of as those parts successively develop themselves. Now we set out with a definite electrical attraction which has led us to comprehend better than we otherwise could have done the electrical law of the squares of the quantities learned as the simple indications of experiment; and we are now about to consider these two features of our theory in conjunction; from doing which we shall surely derive, on mechanical principles, the causes that operate for the distribution of electrical charges on the surfaces of bodies generally. We shall begin with such bodies as may be supposed, during our examination, to be surrounded freely by the atmosphere, the pure influence of which is not being interfered with; and when that, the most simple class of cases is disposed of, we shall proceed to apply the same principles to others of a somewhat more complex character.

57. Imagine we have obtained by some means a quantity of electricity, which we hold as a plus charge on a mere point of conducting matter, insulated entirely by the atmosphere. Under such circumstances what will the plus electricity do? Our theory demands that it shall attract its own normal proportion of common matter somewhere, and the nature of attraction requires that the common matter so attracted shall be at the least possible distance. But the nearest common matter to the plus charge is the surrounding air; which not only is already united by nature to its own proper quantity of electricity, but, by reason of the air being an insulator, it also cannot readily part with any portion of it. In such a state of things can the common matter of the particles of air cease to attract their own electricity, for that is the only way in which they can become qualified to attract the plus electricity that is foreign to them? To do that they must, of course, be able to attract the foreign electricity with the greater force. Now that, as we shall see, is just what the electrical law

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of quantity enables them to do; and what the definite nature of the electrical attraction insists upon their doing!

58. It is most important for us to understand this very clearly. First let us imagine the plus electricity in the point to be expending its force upon such a quantity of surrounding aërial common matter as will be attracting *exactly as much* electricity of its own; then so far as the electrical law of quantity is concerned, the forces will be equal, and any little difference of distance that there might be, would determine which of the two lots of electricity should virtually belong to the common matter.

59. But that case is only one of two that may occur; suppose, instead of the common matter being thus limited, that the plus electricity were to act upon two such units of air, then the common matter of each of those units will have to abandon only one half as much of its native electricity, which half is being retained with only one fourth the force that is being exerted upon it by the plus charge double in quantity; and therefore under such a predominating excess of force the native electricity will virtually be dismissed, becoming to its own common matter a plus charge. Now there will be two such plus charges, one in each unit of aërial matter, and the two taken together, although more diffused, will, of course, be exactly equal in quantity of electricity to the plus charge by which they were originated, or, as we express it, *induced*.

60. So far, then, we have static electrical induction setting out from a point, and propagating itself to two points. We may next suppose that each of the two units of aërial matter, which is sustaining under one fourth of the original intensity half the induction of the originating plus charge, finds two other units of air on which to act by induction; it will then, in its turn, set up in each of them an induced charge equal in quantity of electricity to one-fourth part of the originating charge, that fourth exhibiting in obedience to the law of quantity only one sixteenth part of the original intensity.

61. We need not follow this action any further, as it is quite easy to perceive that electrical induction originated in the way we are representing, may be propagated under progressively diminishing intensities, among contiguous particles of air, so long as those particles present themselves in constantly increasing numbers, or until the action expends itself by diffusion. And we can understand also that the *quantity* of the induction is always maintained throughout without loss, that is to say, the induced charge at every successive step of the outward action is precisely equal to the charge which induces it, although the intensity of its action, and consequently of the reaction opposed to it, progressively diminishes, until at last it becomes insensible in the distance.

62. But to establish this as the *rationale* of electrical induction, we must show that upon all occasions in which it may be observed around charged conductors freely insulated in the air, opportunity is afforded for the diffusion of the inductive action, and consequent reduction of intensity, by the successive presentation of increased quantities of common matter. It is quite obvious that in the case of a plus point insulated in the atmosphere, the necessary conditions do exist; because the spherical form of its aërial envelope, surrounds it at successive distances with progressively increasing quantities of aërial matter, which at length may be so great as to reduce the evanescent intensity to an inappreciable amount. On the other hand, as a plus charge supposed to exist on the inner surface of a hollow sphere could have presented to it inwards no such progressively increasing quantities of aërial matter, it ought, by our theory, to have no power of propagating induction from one distance to another under intensities of action progressively diminishing.

63. We have given the above *aperçu* of static electrical induction to foreshadow its more circumstantial application to cases of practical occurrence. It would be hard to say what part of electrical science has been regarded as most replete with mysteries, but certainly that now before us has been allotted its full share; so much so, indeed, as to have been assumed to be a distinct function of electricity, put into action by it for preparing the way for the exercise of its forces of attraction and repulsion. If we succeed in dismissing all this mystery, reducing repulsion, induction, and attraction to one simple function of one simple force of one simple electricity, the student may reasonably take courage, and be full of hope that other now unapproachable difficulties, when their time to be examined shall arrive, will, in the light of our theory, become equally intelligible. We would encourage him to expect that he himself is likely to achieve more than any of his predecessors, or any long-waited-for scientific Hercules, to shoulder forward the wheel so long at a stand still, if he only bring to the undertaking average qualifications, an indomitable disregard for prejudices, and a moderate amount of perseverance. The field is large and rich enough for every one who labours in it to prove a discoverer.

64. We have seen in several of our experiments, that moveable bodies may be made to approach through a sensible distance to other bodies that are electrically charged; and it is usual to impute this fact to the force of electrical attraction operating between them. The fact has generally been received as conclusive evidence of a power in electricity to project its attraction through space, with a force that becomes less as the distance increases; and M. Coulomb, by measuring the force at certain different distances, and taking the doctrine of the projection through illimitable space to be true, arrived at a conclusion that electrical attractions vary in an inverse ratio of the squares of the distances; that is to say, if any particular distance is reduced to one-half, the force acting at the original distance becomes, by reason only of that reduction, $2\times2=4$; or, if the original distance be reduced to one-fourth the force is thereby raised to be $4\times4=16$. Faraday, without altogether denying the projection of electrical force through great spaces, thinks it may be propagated by some kind of action of one particle, or molecule of common matter on others contiguous to it, our theory inevitably requires that plus electricity in common matter should act inductively on other contiguous common matter, because it cannot be without attracting common matter at the smallest possible distance. But that is no proof that it would not so act across empty space, even to unlimited distances, if no common matter were nearer; indeed, we cannot help regarding even the propagation of attraction from particle to particle as a projection through space of small magnitude, and if the projection be in any case admitted, it would be difficult to justify its limitation to any distance short of infinitude.

65. So far as we at present know, we do not require to regard the law of Coulomb as a normal law of electrical force; the ratio of the inverse squares of the distances has been derived from observation taken under circumstances in which the ratio admits of explanation without it; and instances are not wanting to show that it is untrue under other circumstances in which, if it were a law of force, it ought to obtain also. We purpose to make no use of it.

66. Geometry, where we can apply it, is a safe guide, and fortunately its elementary truths are simple enough to be used by any tyro. We shall now take it into our service. Spheres increasing by successive increments have surfaces that are relatively to one another as the squares of their radii or their diameters; so that if one sphere have twice the radius or diameter of another, it will have a surface $2\times2=4$ times as large; if it have 3 units of radius it will have 9 units of surface; if 4 of radius, then 16 of surface, and so on. It follows from this that the aërial matter at successive equal distances from a point freely surrounded by the atmosphere, must be in quantities that increase as the squares of those distances. Now, if we trace electrical induction outwards from a central plus point from one distance to another, we shall perceive that if at any given distance it fall upon common matter represented by an unit of quantity, at twice that distance the matter it falls upon will be represented by 4

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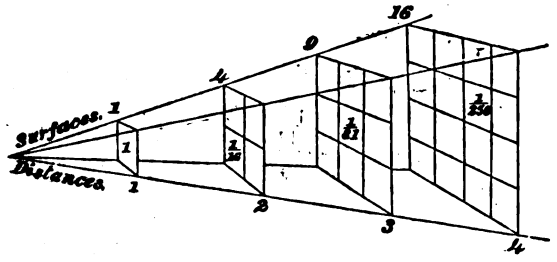
units of quantity, at three distances 9 units, at four distances 16 units, and so on. Therefore, by dividing the electricity in action, which is at all distances the same in quantity (59·60), equally between the particles of air at the several distances, the quantities of electricity falling to individual particles successively will be relatively as 1, $\frac{1}{4}$, $\frac{1}{9}$, $\frac{1}{16}$, and so on; and, coupling this with the electrical law of quantity, we shall have for the intensity of induction on each particle at the first distance $1 \div 1 = 1$; at the second distance, $\frac{1}{4} + \frac{1}{4} = \frac{1}{16}$; at the third distance, $\frac{1}{9} + \frac{1}{9} = \frac{1}{81}$; and at the fourth distance, $\frac{1}{16} + \frac{1}{16} = \frac{1}{256}$.

67. Thus the induction originated at a central point, and propagated outwards to successive spherical shells of air (though the induced charges in all the shells be in quantity exactly equal to one another, because they are each equal to the original inducing charge), will be as it falls upon individual particles of air reduced in intensity in the very rapid ratio of the 4th power of the distances, by which the tyro is to understand the distances expressed in figures, and each multiplied into itself three times.

68. The following diagram (fig. 3), representing four equidistant radii emanating from the same point, will shew to the student at one view that at the distances 1, 2, 3, and 4, there will be inclosed respectively 1, 4, 9, and 16 units of surface; which units, for our purpose, may be conceived to be particles, or any other given equal quantities of air; they are so marked as to denote the theoretical intensity of each particle or unit.

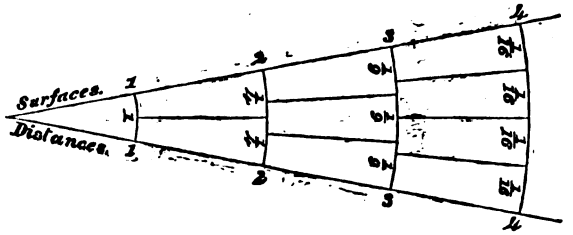
Fig. 3.



69. It is impossible to contemplate this rapid reduction of electrical intensity by surrounding a plus charge by a sphere of aërial matter of adequate radius, without perceiving that it must at no very great distance from the centre, depending upon the magnitude of the original charge, die away into insignificance; giving existence to a state of things that we may understand to be a substitute for the natural electrical equilibrium, and permanent so long as the insulation remains perfect, and the aërial particles undisturbed by any foreign influence. And we know practically that when the atmosphere is particularly dry, and maintained still and quiet around a plus conductor with a smooth surface, supported by a slender and well varnished cane of clean glass, it will retain an electrical charge for many hours together, or even days.

70. To complete this type of static electrical induction, preparatory to applying its principles to the cases we meet with in practice, we must now consider what would theoretically occur on the supposition of our operating with a number of charged points forming a line. Instead of a sphere of atmospheric particles acted upon by induction, we should then have a cylinder with hemispherical ends; with those ends we shall not trouble ourselves, as all we now need to have to do with is the cylinder; which, of course, may be any number of either inches or miles in length. As in the case of a point, so in this: the inductive intensity will be reduced as it becomes propagated outward, but not with nearly so much rapidity, for now we have to do with the circumferences of circles instead of the surfaces of spheres, and the former vary only in the simple ratio of their radii, or diameter, and not like the latter as their squares. We have, therefore, founded upon our electrical law of quantity, a ratio for the intensity of induction around lines, which we are to derive—first, by dividing the quantity of electricity represented by the plus charge equally between all the particles of air at each several distance; by which individual aërial particles at each of the distances, 1, 2, 3, and 4, obtain portions of electricity which are to one another as 1, $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{4}$, respectively. And secondly, by dividing those quantities by themselves, thus making the intensities of individual particles to be in succession, as they are located outwards, 1, $\frac{1}{4}$, $\frac{1}{9}$, and $\frac{1}{16}$. This we represent by the following simple diagram, marking as before each particle, or unit of air, with its particular theoretical intensity.

Fig. 4.



71. We are now quite prepared to shew circumstantially, on mechanical principles, how the force of electrical attraction distributes plus electricity upon conductors under all the circumstances in which we find it distributed, even down to the minutest detail. And also that what is called electrical repulsion is a very plain and simple means of answering the same purpose when the distribution is prevented by insulation.

(To be continued.)

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

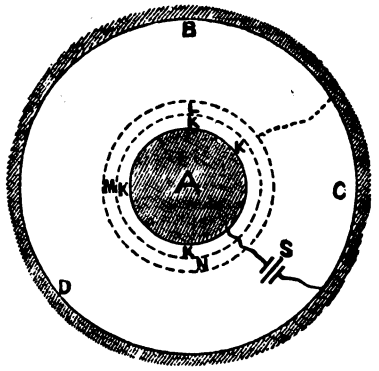
BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 187.]

We have seen therefore, that in every case of electrical accumulation there exists an inductive circuit, and that the strata of dielectric in that circuit offer a resistance to the inductive action by which the accumulation is produced.

Thus if a sphere A (fig. 33), be connected to one pole of a source, the other pole of which is connected to the surrounding

Fig. 33.



surface, B C D, the dielectric intervening will offer a certain resistance in the inductive circuit.

Suppose now the sphere A be surrounded closely by a metallic shell, L M N, and let this be joined to the outer surface. Then the inductive resistance will evidently be reduced. Now if the layer or shell of dielectric separating the sphere A from the shell L M N is very thin, compared to the radius of the sphere A, it may be considered and dealt with as a resistance in the same way as if it were a flat sheet of dielectric of the same area as the surface of a sphere having a radius, A K, equal to the mean between the radii of the inner and outer spherical surface of the shell. Con-

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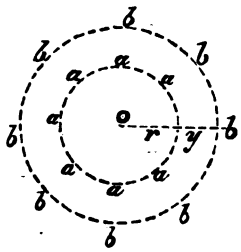
sidered as a resistance in the direction of its thickness, this sheet would have for *length* its thickness, and for *sectional area* its surface.* Suppose now we compare the resistance of numerous layers or shells of dielectrics, of equal but very minute thickness, enveloping the sphere A.

Then it is evident, as we suppose their thickness the same, their proportionate resistance will be inversely as their sectional area (as conductors). But this sectional area would be proportional to the square of the mean radius of each layer, and if we suppose them infinitely thin, the resistance of each layer will be inversely proportional, therefore, simply to the squares of their radius.

Fig. 34.



If r (fig. 34) equals the radius (or distance from the centre, o), of any layer a.

y, the distance between the layer a and another, b, exterior to a.

p, the resistance of a.

x, the resistance of b.

Then the radius of b will be $r+y$, and therefore

$$(r+y)^2 : r^2 : : p : x,$$

or,

$$x = \frac{r^2 p}{(r+y)^2}$$

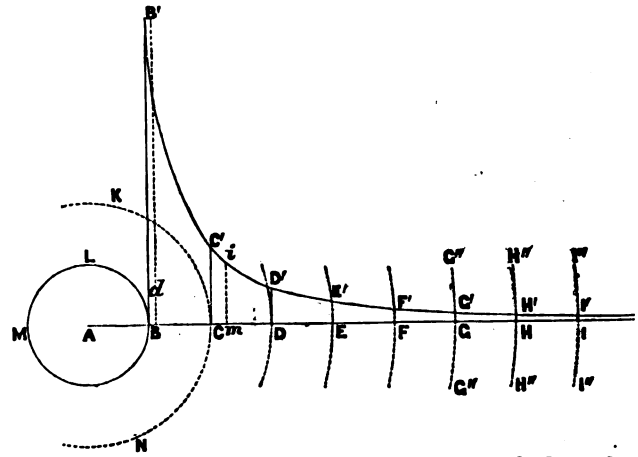
The greater r is compared to y, therefore the less will be the difference between p and x, or resistance of a and b. If a is the interior layer of all, the nearest layer to it will therefore approach more nearly to its resistance than any other.

If y represent the distance between two consecutive layers, then of any two consecutive layers, those will approach the more nearly to equality which have r the greatest, or in fact, which are more remote from o.

Let A B (fig. 35), be the radius of a conductor B L M, and let B B′ represent the resistance of an exceedingly thin shell of dielectric, a, around it, and whose radius may be taken as equal to A B, and whose thickness we call d. Then the resistance of any other thin shell, b, of the same thickness as a, will be to the resistance of a as inversely as the squares of their radii.

Therefore, if A C, A D, A E, &c., represent the radii of different thin shells, if ordinates C C′, D D′, E E′, F F′, &c., be erected at C, D, E, &c., of such a length that A C² : A B² : : B B′ : D D′, and A D² : A B² : : B B′ : D D′, &c., these ordinates still represent the proportional resistance of each shell whose radii equal the abscisses of those ordinates. And if we take a sufficient number

Fig. 35.



of abscisses and ordinates, a curve may be traced through the termination of each ordinate, B′ C′ D′ E′, &c., the ordinate, $m\ l$, of which, taken at any intermediate point, m will give the resistance of the shell whose radius is the abscis, A m.

Now the resistance of any thick shell of a thickness B C, is made up of the sum of the resistances of all the thin shells of d thickness, of which the thick shell is composed.

Now the thickness of each thin shell being represented by d, and its ordinate by o, then if we represent the resistance of each shell by its ordinate *multiplied by d* (instead of simply by its ordinate), they will still retain the same ratio (for we suppose all their thicknesses equal). We thus represent the resistance of any thin shell by an area ($o \times d$), instead of a line. The resistance of any thick shell, whose inner radius is A B, and thickness B C, will be the sum of all the successive d's contained in B C, each multiplied by its ordinate, but this will give approximately the area of the figure B B′ C′ C, and if we suppose d infinitely thin, then it will give the area of B B′ C′ C absolutely. In the same way the resistance of any other shell having an inner radius A C, and thickness C D, will be represented by the area of the figure C C′ D′ D, or any shell whose inner radius is A B, and thickness B G, by the area of the figure B B′ C′ G.

We see here, both from the equation and the geometrical figure, that if we have a conductor closely enveloped by its outer opposing surfaces, as for instance if we had a spherical Leyden jar of an interior radius A B, and exterior radius A x, the resistance will ve very small (being represented by B′ x' x), compared to a conductor B L M, having an opposing surface, whose radius is A I. The resistance in this case being represented by B B′ I′ I. The quantity that will be accumulated in the jar will be much greater, therefore, than in the conductor. And further, we see that when the distance between the inner and outer conducting surfaces is very small compared to the radius of the inner one, the resistance is nearly doubled by doubling the distance between them. And that the greater their radius is as compared with the distance between them, the more nearly will the resistance be doubled by doubling the distance between them. And further, that although, if having a very small distance between the two opposing surfaces compared to their radii, we double that distance, we nearly double the resistance, yet that if we keep increasing the distance between the surfaces, by increasing the distance of the outer conductor, although we increase the total resistance, yet that as the resistance of successive layers decrease at first rapidly with each increment of distance, the increase for any increment of distance soon becomes so small that any further increase of distance will add but little to the sum of the resist-

* The resistance of a conductor to conduction (or of a dielectric to accumulation on its terminating surfaces), which has a continually increasing sectional area, such as a cylinder or a shell (considered as conductors or inductors in the direction of their radius), cannot be obtained, as some electricians have advanced, by taking their mean sectional area for S in the equation $R = \frac{l}{S}$.

Neither does the surface of a sphere whose radius equals the mean radius between the inner and outer surfaces of a shell equal the mean between the inner and outer surfaces of such shell, or in fact its mean sectional area as a conductor in the direction of its thickness. As we are only treating of exceedingly thin layers, with the ultimate view of illustrating geometrically the proportionate resistance between shells composed of many of such layers, the method I have given for the resistance of a single thin layer is sufficiently correct for such purpose, although not in the least so if employed directly for comparing the resistance of two shells of considerable thickness as compared to their radius. The equation known as Professor Thomson's for the resistance to conduction of cylindrical coatings is $R = \text{Log.} \frac{D}{d}$, where D equals the exterior diameter of a coating, and d the inner diameter.

If d be taken as unity, the resistance of coatings whose interior diameters are consequently 1, and exterior diameters 2, 3, 4, &c., will be to one another as the common logarithms of these numbers, or as 0·3010, 0·4771, 0·6020, &c. This may be geometrically illustrated by certain spaces comprised between an hyperbola and its asymptote (in the same way as that shown in fig. 35, with a different curve for spherical shells), and will be given when treating of conduction.

I am not aware of any published formula for the resistances of spherical shells, but both these subjects will be again noticed when treating of conduction, when I hope to be able to bring forward some mathematical investigations on the subject, kindly made, at my request, by Mr. J. A. Longridge, and with which he has been good enough to favour me.

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ances already composing the inductive circuit. Thus, if we have a conductor closely enveloped by an outer opposing surface, such as a spherical Leyden jar, if we double their distance apart we decrease the quantity that can be accumulated with a given source, to nearly half, but if having a conductor whose outer opposing surface is the surface of the room, we move that conductor into a larger room, and then apply the source of generation, scarcely any decrease in the quantity that can be accumulated will result.

It must be borne in mind that this simply gives the comparative resistance offered by such a shell of dielectric in the inductive circuit, the total resistance of which circuit regulates the *quantity* that can *be accumulated* with a given source. When such a shell alone forms the whole resistance of the inductive circuit, as for instance, if one pole of the source be connected to B L M, and the other to an outer opposing surface, then the total quantity that can be accumulated will be regulated solely by the distances between these surfaces in the manner described, and some important points may be discussed.

Suppose A C (fig. 35) the radius of a sphere, K C N, and let C C′ represent the resistance of an infinite thin layer of dielectric next to it. Suppose the outer opposing surface, I I′ L″ L″, to be situated at a distance, A I, then the resistance between C K N and this outer surface will be represented by the area C C′ I′ I. If C K N be reduced to half its diameter to B L M, the resistance of the inductive circuit will be increased by a quantity equal to the area B B′ C′ C. Now, we may suppose the outer surface I I′ I″ so far distant from C K N, that the area B B′ C′ C shall equal C C′ I′ I, which would indicate that by decreasing the diameter of the conductor C K N to half, so that it shall be now represented by B L M, we shall just double the resistance of the inductive circuit, and consequently halve the quantity that will be accumulated, but this is now disposed on *one-fourth* the surface, so that the *density* on B L M will be doubled. Now, if the outer surface I I′ I″ I″ remain constant, and we have a conductor within a portion of the surface of which is represented by H H′ H″, whose radius, A H, is but little less than A I, then if H H′ be the resistance of an infinitely thin layer around H H′ H″, H H′ I′ I will be the resistance of the inductive circuit. If, now, H H′ H″ be reduced in radius to A G, and a portion of its surface represented by G G′ G″, so that G H=H I, then the inductive resistance will be represented by G G′ I′ I. But this is little more than double H H′ I′ I, and consequently the quantity accumulated will be a little less than half that accumulated on H H′ H″. The surface of G G G″ is not half of H H′ H″, however, but only reduced as A H^2 to A G^2. And, consequently, as the quantity accumulated is reduced in a greater proportion than the surface, the density must be decreased.

If G G′ G″ be further reduced in radius, there will be some point at which, if still further reduced equal increments of its radius, the resistance of the inductive circuit will not be so much increased as the surface is decreased, as in the case already cited, when the radius is decreased from A C to A B, and in which case, as we have already shewn, the density will rise.

Thus we see that if we continually decrease the size of a conductor inside a given outer surface, although by so doing we continually increase the resistance of the inductive circuit, and consequently continually decrease the total quantities that can be accumulated, yet that, although when the conductors have certain proportions a decrease decreases the density, when decreased beyond a certain ratio this *density* will increase.

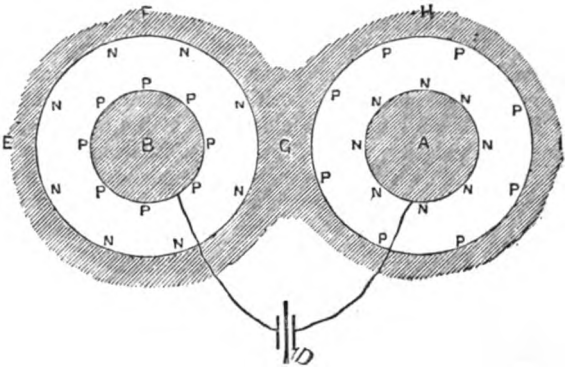
Now the conductive resistance or insulation follows the same law as the inductive resistance, and consequently if the density increases in the case of small conductors in a more rapid proportion than the resistance to conduction, or in fact than their insulation, some action like conduction must ensue.

Indeed, this seems to agree entirely with practice, for we know that if we have a large conductor closely opposed on all sides by the outer opposing surface, and then decrease that conductor so that the shell of dielectric separating them be doubled in thickness, the density will be, with the same source applied, nearly halved; yet if we decrease the interior conductor to a mere point, the density will be exceedingly high, and what is known as discharge by convection brushes, &c., will take place.

The resistance of any part of the inductive circuit affects the accumulation on all the surfaces in the circuit; for we have already seen that these are always equal and opposite.

If, therefore, in Fig. 14, the conductor A be increased in size,

Fig. 14.

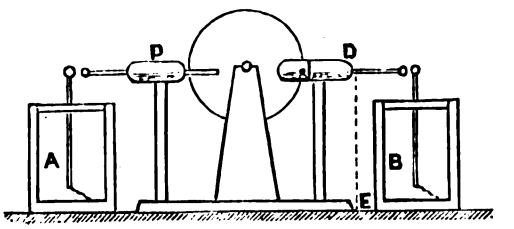


and thus the resistance of the shell of dielectric surrounding it be decreased, the accumulation on all the surfaces will increase as the total resistance of the inductive circuit is decreased.

If now A be joined to its outer opposing surface, the inductive resistance of the circuit will be evidently *halved*, and the same source will be able to accumulate *double* the quantity on B and its surrounding surface.

Thus, suppose we have the interior coating of a Leyden jar A (Fig. 36) attached to the prime conductor P of an electric

Fig. 36.



machine, and the interior coating of another jar B attached to the insulated rubber, whilst the two outer coatings are in conductive connection, either by being both in connection with the ground, or, if both are insulated from the ground, then by a chain between them. Then an inductive circuit through the two jars will be formed, resembling the one illustrated in Fig. 14. With such an arrangement, a certain accumulation can be effected in the two jars, the one becoming charged positively, and the other negatively, whilst the inside of their outer coatings will be in the opposite state to their interior coatings. If now the rubber D be connected to the outside coatings by a conductor D E, then the jar B will be discharged, and will be no longer in the circuit, which now contains only one jar. The resistance of the inductive circuit is therefore halved, and double the quantity can, with the same source, be accumulated in the jar A.

(To be continued.)

ELECTRO-POLARIZATION.

BY W. H. PREECE, ASSOC. INST. C.E.

Nothing is more perplexing to the student of electricity than the inappropriateness and inaccuracy of many of the most important

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terms employed to designate the various properties of currents, and the conditions from which they arise. The arbitrary terms positive and negative are frequently misplaced and often misunderstood. Electro-motive force, tension, intensity, and quantity are almost invariably confused and incorrectly applied. But perhaps no term is adopted with less propriety, in the explanation of certain phenomena, than that of polarization. While I leave to more experienced hands the correct interpretation of the other illused terms, I will devote a few lines to the examination of the phenomenon which is known as *electro-polarization.*

Polarization, strictly speaking, is the act of giving polarity to a body, or supplying that quality in virtue of which peculiar and contrary properties reside in opposite points; thus a magnet is polarized, it has one property of attraction at one end, and another property of repulsion at the other end. A body electrized by induction is also polarized—positive electricity accumulates at one of its ends, and negative electricity at the other. Light is endowed with polarity, that is, the opposite sides of a particle of light are invested with different physical properties. The molecules of the exciting liquid of a battery may, when in action, be strictly considered to be polarized—positive and negative electricity are developed on opposite sides, the one tends towards, and is accumulated on the copper plate, and the other similarly accumulates on the zinc plate. The particles of the dielectric of a Leyden jar are polarized.

Polarization may, therefore, be termed the constrained position in which the particles of a body are held, by the exertion of some extraneous force, which lasts during the existence of that force, and which can only be neutralized by the action of some foreign means or power. When the opposite poles of a magnet, or the opposite sides of a Leyden jar are united, we obtain neutrality. When the ends of a battery are connected, we have a current. Currents of electricity may arise through a difference of tension in different points of the same body, or through a difference of electricity in two bodies. But in the whole range of electrical science I know of no phenomenon where a current can be said to be generated by the simple polarization of a single mass of metal.

Now Professor Wheatstone, a great authority in electrical and physical science, in accounting for certain phenomena observed on short wires (*vide* Government Report, p. 287) says, "the cause of these effects is the polarization of the plates, or masses of metal, connecting the ends of the wires with the earth. The first effect is produced by the polarization of the terminal which connects the telegraphic wire with the earth; the second, by the polarization of the terminal which connects the galvanometer with the earth." Such an explanation, emanating from such an authority, is so liable to mislead and confuse the juniors in the science, that I feel bound to endeavour to prove its fallacy, and at the same time to throw a little light on these so called "currents of polarization." I will first describe these peculiar currents and their true source, and then attempt to refute the learned Professor's unaccountable exposition of their cause.

First, then, with regard to these "currents of polarization." Ritter, according to De La Rive, in 1803, found that a pile constructed of layers of the same metal, separated by cards moistened with a saline solution, acted momentarily as an ordinary pile on passing a current through it for a short period. He called this action *secondary.* It increased with the current, the surface of the metal, and the conductivity of the liquid. Volta traced it to the action of the primary current decomposing the liquid into an acid and an alkali; and De La Rive showed that this secondary current gave all the indications of an ordinary current, but in the opposite direction of the primary current. He called it *secondary polarity.* He also produced the same effects in pure and acidulated water, where there was no alkali, and attributed them to the polarity of the electrodes themselves; but Becquerel proved that such an action could not take place when the circuit was all metallic, and that contact with moisture was essential to their production. He attributed their existence to the small gaseous films deposited upon the electrodes during electrolysis—a view confirmed by Matteucci with experiments upon the purest water. The latter philosopher investigated the subject very deeply, and obtained the most interesting results. He found that the electrodes retained their polarities for a long period, and could only be totally destroyed by heating them to redness. One of the electrodes might be replaced with an unused plate of platinum, and the effect still continued. It was greater with the oxygen than with the hydrogen plate. The existence of these films of gas upon the plates was distinctly proved by direct experiment. The currents could also be produced by placing the plates in pure gas, and then dipping them in pure water, without the assistance of the primary current. The current always proceeded from hydrogen to oxygen. One plate in hydrogen or oxygen alone, with an untouched plate, was sufficient to produce a current, that of the hydrogen being positive, and that of the oxygen negative—platinum or gold plates being used.

Shœnbein, the discoverer of ozone, also investigated the matter, and attributed the effect to the existence of ozone. He produced the same effect with chlorine, bromine, and iodine.

Grove, following up the subject, produced his beautiful gas battery—a battery whose action depends upon the same properties as those which produce currents of polarization. He also showed that this deposition of gaseous films, and consequent polarization of the electrodes, increases the resistance of electrolytic fluids to decomposition, and arrests it altogether when a simple cell is used. He calls it *voltaic reaction.* It is also for this reason that the accumulation of hydrogen on the positive plate of an ordinary battery reduces its action, and led Daniell to invent his excellent arrangement.

M. E. Becquerel endeavoured to estimate the electromotive force of such polarized plates; but he found great difficulty in doing so, owing to their excessive variation. He found, with platinum plates, 1·55 square inch area, placed in acidulated water, and using 8 Bunsen cells:—

Hydrogen plate	...	...	...	...	37·62
Oxygen „	...	...	...	...	53·56

100 being that of one cell of platinum and zinc of similar size in diluted sulphuric acid. He measured their electro-magnetic energy upon a delicate magnetometer.

Jacobi has proposed the use of secondary piles for telegraphic purposes; and Planté has increased their power by using peroxide of lead in place of platinum plates. He finds the power of such secondary piles to be six times that of ordinary platinum, and attributes the result to the powerful affinity of peroxide of lead for hydrogen.

Dr. Carl, of Munich, has recently measured these currents produced by buried zinc plates. He found, by using one weak cell (Daniell's), that immediately on the removal of the cell, the galvanometer deflected 7°; after 1 minute, 3·8°; 5 minutes, 1·1°; and 10 minutes, 0·2°.

Professor Wheatstone also measured and investigated the currents produced by buried metals, and it is his explanation of his observations that has led to this enquiry. He found:—

1st. The length of wire between the earth plates and the galvanometer remaining the same, the deflection of galvanometer increased with the battery to a certain limit.

2nd. When one or two cells were used for the primary current, the deflections were constant.

3rd. With one cell, the deflection through one mile was 90°; eight miles, 70°; sixteen miles, 25°.

4th. The greater the number of cells, the greater is the first deflection of the needle, and the longer its continuance.*

The nature of the earth plates is not named.

I will conclude this historical account of previous observations

* This is not strictly correct, as my subsequent experiments will show.

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of these phenomena by extracting from a paper on Submarine Telegraphy, which had the honour of being read before the Institution of Civil Engineers, in November, 1860, some observations of my own. In detailing some experiments upon the resistance of ends of broken cables, the following remarks were made:—

"Gas currents were observed immediately after breaking contact.

Positive primary gave negative gas currents	...	15°
Negative „ „ positive „ „	...	20°

No great variation; duration about one minute, declining rapidly in first two seconds, then gradually falling to zero; power used, 48 cells; vertical galvanometer.

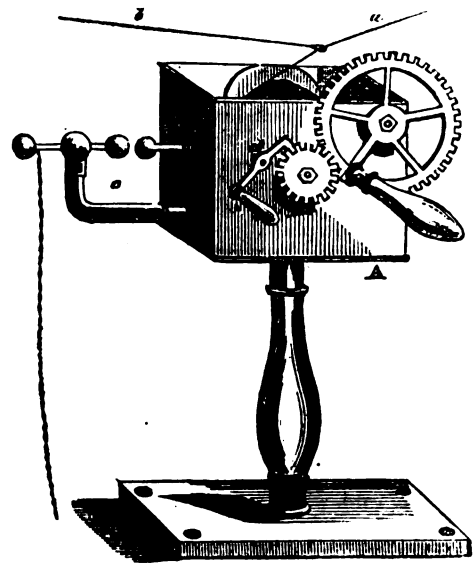
"When the resistance of the end of the cable is small, and the break is not very distant, it is impossible to place any reliance upon the discharge of the wire to verify its resistance, because a very peculiar effect is produced. When a negative current is sent through the wire, it is well known that its end is covered with hydrogen gas, by the electrolytic action of the current upon the water; and by the same means the end becomes coated with oxygen, when a positive current is used. Now, these two gases, acting upon the exposed ends, generate themselves weak currents, which are often mistaken for discharge. The author designates them 'gas currents,' to distinguish them from the 'water current' which is always generated by the voltaic arrangement of the exposed copper end, sea water, and outside iron covering. A positive primary current generates a negative gas current, and *vice versâ*. The duration of the current is but momentary, nor does it vary much with the surface of copper exposed. Its electromotive force is slight, but it renders perfectly nugatory any attempt to verify the resistance tests of short lengths by those of induction. When the copper wire is in contact with the outer iron wire, a case of extremely rare occurrence, these currents are not observed, nor does the end give any resistance."

It may also be stated, as is well known, that in electrolysis, oxygen, acids, chlorine, iodine, and their relatives become free upon the surface of the positive electrode, whilst hydrogen, alkalies, and the metals always show themselves upon the negative electrode. Again, the former substances invariably take a negative, while the latter assume a positive tension. It therefore follows that when a current is transmitted through an electrolyte, whether in the shape of a pile, the water of the ocean, or as the moisture of the earth, decomposition occurs. A substance having a negative tension becomes free on the positive electrode, whilst a substance having the opposite tension becomes free on the negative electrode. Such tension is acquired by the electrodes. Conditions for the generation of a current exist, and, on completing the circuit, such current becomes visible. These currents have been variously termed "secondary currents," "secondary polarities," "currents of polarization," "voltaic reaction," "electro-polarization," "polarization of electrode," and "gas currents." The most appropriate term is unquestionably that of Grove, but I will adhere to my own designation as being quite as correct and more distinguishable from other terms indicating phenomena of a similar nature, by those who, like myself, are but on the threshold of the science.

(To be continued.)

THE ELECTRICAL KITE APPARATUS.

By means of exploring rods and wires, the electricity of the *lower* atmosphere may be easily collected and examined, but for bringing it down from the higher regions the grand Franklinian kite experiment must be resorted to. The experiments with the electrical kite are very interesting, but great caution is required, and poor Richman's untimely end should be steadily before the mind while conducting them. When thunder-clouds are about, the string should never be allowed to pass through the hand while raising the kite, even though it have a good connection with the ground: indeed, even under a cloudless sky, during a smart north-east breeze we have frequently experienced very unpleasant shocks whilst letting out the string. By employing, however, the little apparatus shown in the figure below, complete security is insured, and we strongly recommend it to the no-



tice of kite experimenters. A is a square copper box supported on a stout glass pillar (not less than two inches thick), and firmly cemented into a base-board, which is secured to the ground by strong iron pegs nine inches long, passing through the holes and driven into the ground. The box contains a reel round which the wired string is wound: it is turned by a glass handle fixed on the multiplying wheel. *d* in a small catch moved by a key furnished with a glass handle, by which the reel may be stopped when required without touching the string. *c* is a Lane's electrometer provided with a screw adjustment, by which the distance between the brass balls may be regulated with the greatest nicety; it is connected with the ground by a chain or wire. The method of using this apparatus will immediately be understood. When the kite (which may be simply a silk handkerchief, stretched on a cross of light wood) is raised a sufficient height from the ground for the wind to act upon it, the string need no longer be held in the hand, the kite draws it from the reel, and the experimenter, by means of the catch and key, has it under his complete control. When a sufficient quantity of string has been taken out, a silk cord, two or three yards long, is thrown over the string, and, by means of a running noose, tightened upon it, and the other end made fast to a post; by this means the strain is taken off the box. On ordinary occasions, that is, when no unusual exhibitions of electricity are anticipated, the balls of the discharger may be set about one-fifth of an inch apart, and, instead of connecting the sliding wire with the earth, it may be put into communication with the interior coating of a Leyden phial. In a few minutes, sparks pass between the balls, and on fine dry days, when the wind is in the north or north-east, with about half a mile of wired string out, we have frequently had discharges at the rate of one a minute from the jar, through a striking distance of one-fourth of an inch, for hours together. In order to test the species of electricity collected, the jar is discharged through a helix of copper-wire, enclosing a needle: after five or six explosions have passed, the needle becomes magnetized, the direction of the poles indicating the manner in which the jar was charged. If the helix be a *right handed* one, that is, one in which the convolutions take the same direction as that in which the hands of a watch move, then, if the jar be charged *positively*, that extremity of the needle lying in the coil, which is nearest the *negative* or outside coating of the jar, will become a north pole. If the helix be left-handed, the results are exactly the reverse.

It is most interesting to watch the effect of clouds passing near the kite, their presence being invariably indicated by the increased rapidity of the discharges between the balls; the distance at which the electricity is communicated is indeed astonishing. We have frequently observed a very marked alteration in the discharges from the approach of a single and small cloud before it could have reached within half a mile of the kite, and we have often astonished by-standers who have been amusing themselves by drawing small sparks from the string with their knuckles, by watching the opportunity presented by the approach of one of these clouds, and then desiring them to repeat

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their experiment, and the result has generally been a shock, which has taught them to treat the apparatus with far greater respect than before.

One of the first things that the kite experimenter will probably notice, is the peculiar pungency of the spark: we are accustomed to receive sparks an inch long from the prime conductor of an electrical machine, for amusement; it would not, however, be safe to approach a kite-string from which sparks of such a length might be drawn. The shock from sparks half an inch long are generally very severe, and resembling more the shock from a highly charged small Leyden phial, than that from the prime conductor: the length of the spark is not, however, altogether the criterion of the intensity of the electricity, which depends upon the quantity of string extended, and more still upon the state of the atmosphere.

It is sometimes necessary to penetrate regions of the atmosphere beyond the height attainable by a single kite, before signs of electricity can be obtained; this may be done by letting two, three, or more kites fly from the same string. The first kite is sent up as usual, and when it has reached its maximum elevation, the end of its string is put through a slit in the middle stick of the second, and tied to its string: the second kite is then raised, in like manner a third may be added, and thus great heights may be reached, provided the wind is blowing the same direction in all altitudes. Mr. Cuthbertson, "Practical Electricity," relates the following experiment where three kites were employed:—"Some years ago, in the month of May, I let a kite fly with 500 feet of cord, which seemed to be as great a weight as it could carry, but as no sparks could be got from the wire in the string, and the kite could not rise higher, I fastened a second to it, and they both continued rising, till the second had 500 feet more cord, but still it showed only faint signs of electricity. A third kite was then added, which took 500 feet more, and then sparks were drawn, but very weak, only just felt in the finger. The wind was south-west, and the sky covered with clouds. I had observed, that in such a state of the atmosphere, little or no electricity could be obtained, and that the electricity was the strongest when there were no clouds, or very few, excepting in thunder-storms. I often repeated such experiments at that time, and always found the electricity from the kites to be *positive*, but other writers make mention of having had both *positive* and *negative*."

Mr. Sturgeon's kite experiments appear to have been very extensive. "I have made," says he, "upwards of five hundred electric kite experiments, under almost every circumstance of weather, at various times of the day and night, and in every season of the year; I have experimented on Shooters Hill, and on the low lands on the Woolwich and Welling sides of it, and the experiments in the three different places within an hour of each other; I have done the same on the Chatham lines, and in the valley on the Chatham side of them; on Norwood Hill, and in the plain at Addiscombe; also on the top of the Monument in London, and on the top of some of the high hills in Westmoreland, and in the North Riding of Yorkshire; and in every case I have found the atmosphere *positive* with regard to the ground. I have floated three kites at the same time at very different altitudes, and have uniformly found the highest to be *positive* to the other two; and the centre kite *positive* to that which was below it; consequently the lowest was negative to the two above it, but still positive to the ground on which I was standing. I have made more than twenty experiments of this kind, and the results (with the exception of electric tension) were invariably the same, showing most decidedly that the atmosphere, in its undisturbed electric state, is more abundantly charged than the earth, and, as far as I have been able to explore it, still more abundantly in the upper than in the lower strata."

On the the evening of the 14th of June, 1834, Mr. Sturgeon sent up a kite during a thunder-storm at Woolwich, and the following is the description he gives of the phenomena observed:—"The wind had abated to such a degree before I arrived in the barrack field, and the rain fell so heavily during the time I was there, that it was with some difficulty that I got the kite afloat, and when up, its greatest altitude, as I imagine, did not exceed fifty yards. The silken cord also, which had been intended for the insulator, soon became so completely wet that it was no insulator at all: notwithstanding all these impediments being in the way, I was much gratified with the display of the electric matter issuing from the end of the string to a wire, one end of which was laid on the ground, and the other attached to the silk at about four inches distance from the reel of the kite-string. An uninterrupted play of the fluid was seen over the four inches of wet silken cord, not in sparks, but in a bundle of quivering purple ramifications, producing a noise similar to that produced by springing a watchman's rattle. Very large sparks, however, were frequently seen between the lower end of the wire (which rested on the grass) and the ground; and several parts of the string towards the kite, where the wire was broken, were occasionally beautifully illuminated. The noise from the string in the air was like to the hissing of an immense flock of geese, with an occasional rattling or scraping sort of noise.

"Two non-commissioned officers of the Royal Artillery were standing by me the whole of the time. Unaware of the consequence, they would very gladly have approached close to the string; and it was not until I had convinced them of the danger of touching or even coming near to it at the time the lightning was playing about us in every direction, that I could dissuade them from gratifying their curiosity too far—probably at the expense of their lives. We anxiously and steadfastly watched what was going on at the end of the string, and the display was beautiful beyond description. The reel was occasionally enveloped in a blaze of purple arborized electrical fire, whose numberless branches ramified over the silken cord and through the air to the blades of grass, which also became luminous on their points and edges over a surface of some yards in circumference. We also saw a complete globe of fire pass over the silken cord between the wire and the reel of kite-string. The soldiers thought it about the size of a musket-ball. It was exceedingly brilliant, and the only one that we noticed."—*From Noad's Manual of Electricity.*

TESTING OF SUBMARINE CORES IN VACUO.

It is well known that the core of the Malta and Alexandria cable was in the course of manufacture subjected to the following tests, with a view of detecting faults, such as air cells, &c. The core (in coils of certain lengths), was first placed in water, at a temperature of 75°, and then tested for insulation. It was afterwards placed in a pressure tank of the same temperature, the ends of the coils being brought out for electrical tests through air-tight stuffing boxes. The air being exhausted from the pressure tank, it was believed that the air mixed up with the gutta percha in the process of manufacture would have been entirely withdrawn from the air cells, &c.; and that when water was admitted, that it would have instantly occupied the space in the gutta percha formerly filled with air. That the exhaustion of the air from the pressure tank did not effect the object in view is evident from the following fact. The conductor consisted of seven copper wires formed into a strand, and its insterstices filled with air. The ends of the core were carried out through the stuffing boxes, as already described; so that the core formed as it were a tube with both its ends open, and the exhaustion of the air of the pressure tank could not have had any effect upon the air in the inside of the tube, or otherwise no vacuum could have been obtained, as fresh air would have been supplied from without through the open ends of the core.

The following experiments were made to ascertain how far the test in vacuo affected the condition of a gutta percha and "compound" core. Two lengths of 12 inches each in length of the Malta and Alexandria core were placed in a basin of water at a temperature of 75° for four hours. One piece was taken out and had both its ends hermetically sealed. (This core consisted of 7 copper wires, twisted into a strand, and was coated with coatings of gutta percha and Chatterton's compound.) The diameter being carefully measured, it was placed in a receiver, and the air completely exhausted. Upon removing the piece from the receiver, it was found that it had increased in diameter, but irregularly so. When a portion of the outer gutta percha layer was removed, the compound between it and the other layer of gutta percha had a spongy or cellular appearance, and the coating of gutta percha was easily stripped off, the junction between the coating and the compound having been disturbed by the expansion of the air which must have existed between them. Carefully comparing with the aid of a lens the air cells and crevices detected in the piece subjected to the above test in vacuo, with those in the other piece which had not been treated, it was evident that the cells and crevices in the former were enlarged by the expansion of the included air. The coatings of the latter piece firmly adhered together, and the compound was not in anywise affected.

A piece of india rubber core was also subjected to a similar test, by being placed in an iron pipe. The air in the pipe having been exhausted, water was forced into the pipe, until a considerable pressure was obtained, when a loud and terrific explosion took place, forcing a portion of the core out through the fractured side of the pipe. Upon examining the piece of the core forced out, it presented a most singular appearance, having a series of bladders filled with air, from a quarter to half an inch in diameter formed upon its surface. The portion of the core left in the pipe had been completely shattered, and the

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rubber torn from the copper wire, and all the coatings separated from each other.

It is evident that to subject cores of any description to such a treatment as above described, results in a positive and permanent injury thereunto.

The Student.

One of our recent correspondents mentions a plan of employing coke or gas carbon in small irregular pieces for the negative element of the battery, using a larger fragment for connecting the terminal wire (p. 130). This method certainly obviates the difficulty of cutting and shaping the hard carbon, and, when due care is taken to ensure contact between the fragments respectively, it answers perfectly the object in view. The wire connection is the next thing to be considered. In the original battery of Bunsen, each carbon cylinder carried at its upper extremity a collar of copper, to which was attached a strip of the same metal. Owing to the porosity of the carbon, and the consequent action upon the copper collar of the absorbed nitric acid, this connection frequently became defective. A collar of lead has subsequently been adopted with some advantage. The following plan will, however, be found the most efficient for securing a good and permanent connection between the carbon element and its attached wire.

A portion of the carbon plates, cylinders, or pieces to which the wire is to be attached, is electro-plated with copper by means similar to the following; and a strip or wire of copper can then be readily attached by solder. A saturated solution of sulphate of copper, with a few undissolved crystals to supply waste, is placed in a shallow dish, in which also stands a porous vessel containing a plate or cylinder of amalgamated zinc in dilute sulphuric acid. The pieces of carbon are bound together, and attached to a wire leading from the zinc in the porous vessel. They are then partly immersed in the copper solution, so that the portion of their surface to which the connection is to be made, may become covered with reduced copper by electrolysis. Several days are generally required for this purpose.

The best forms of carbon for battery purposes are more or less porous. This porosity enables us, advantageously in some respects, to dispense with the porous vessel in which the carbon negative is generally contained; thereby increasing the quantity of electricity produced from the battery, by removing a portion of the resistance in the voltaic circuit. Thus if the battery be required to remain in action for a short space of time only, the cylinder of graphite or carbon may be saturated with nitric acid, and placed inside the zinc cylinder, without employing any porous partition between the elements. Precautions must however be taken to prevent contact between the carbon and zinc in the cell. The following method enables us to keep the carbon element constantly saturated with nitric acid, or any other *soluble* exciting fluid, without the employment of a porous vessel. A cylinder of glass, about two inches high, and of somewhat greater diameter than the carbon cylinder, is placed round the upper portion of the latter, and is maintained in this position by clay or plaister, in such a manner that the glass may form a shallow vessel surrounding a portion of the carbon element, and capable of containing a portion of nitric acid. For this purpose, a plate of metal, having a circular aperture in it, of the exact size of the carbon cylinder, may be slipped upon the latter, and held about 3 inches from its upper extremity. The cylinder of glass, cut from a tube, may rest upon the upper surface of the plate, being concentric with the carbon cylinder; and a ring of clay may then be introduced between the glass cylinder and the carbon, and moulded upon the metal plate by means of a piece of wood, so as to form the bottom of the vessel to surround the carbon, after which the metal plate may be removed. The nitric acid placed in this vessel is gradually absorbed by the carbon, and maintains its efficiency as a negative.

The peroxide of lead, formed into a paste with water, is so excellent and convenient a material for the exciting fluid, especially in the case of carbon as the negative element, that it may be of advantage to those who employ the voltaic agency to give some instructions as to the means for obtaining this substance.

Peroxide of lead may be formed, 1st, by heating litharge (oxide or protoxide of lead) with ¼ of its weight of chlorate of potash, 2nd, by boiling minium or red lead (sesquioxide of lead) with nitric acid, collecting and washing the residue; and 3rd, by Wöhler's process, which, in preparing a considerable quantity of the material, will be found the most economical. This process is as follows:—Dissolve 4 parts of crystallized acetate of lead (sugar of lead) in a sufficient quantity of water; and to the solution add ¾ parts of crystals of carbonate of soda (common soda). Arrange a Florence flask with a bent glass tube, fastened in the neck of the flask with a cork, for the purpose of producing chlorine gas, which is to be passed through the pasty mass of carbonate of lead which we have formed. The chlorine gas is evolved by slightly heating a mixture of muriatic acid and peroxide of manganese in the flask. When the evolution of gas ceases, the end of the tube which dips into the fluid must be withdrawn, or absorption will take place within the flask, probably causing its fracture. The gas is passed into the mixture, the latter being frequently stirred, until the whole of the *white* carbonate of lead is converted into the *brown* peroxide, which may be collected upon a filter and carefully washed.

REPORT OF THE LONDON DISTRICT TELEGRAPH COMPANY.

The accompanying statement shows by comparison a nett increase of £1,533 16s. 8d. over the receipts for the corresponding period of last year, and £455 14s. 3d. over the past half-year. In making this latter comparison, it should be borne in mind that the usual vacation months have intervened, and commercial enterprise has been unusually languid for the greater portion of the period. The gross receipts, which include the provincial and continental messages, show a still more favourable comparison.

The general working expenses have remained about the same, although fifteen new offices have been opened. The principal increase occurs in the engineering maintenance, but this subject is now receiving the anxious consideration of the directors, and they hope to be able to effect some reductions in this item of expenditure.

The directors regret there is still a considerable deficiency, which, they have every reason to hope, may be overcome by the progress of the undertaking; and they are glad to state, that a proposal is now before the Directors of the Magnetic Telegraph Company, which, if adopted, will ensure a considerable reduction in the general working expenses, and an increased profit for collecting provincial messages.

On previous occasions the directors have called the attention of the shareholders to the desirability of entering into contracts for providing and maintaining private telegraphs. The present income from this source amounts to about £1,000 per annum, the agreements being for definite periods. These contracts have hitherto been chiefly provided for by existing wires, so that, although no provision was made in the first instance, the outlay for works up to the present time has not materially exceeded the original estimates. As, however, several desirable contracts have been proposed, and the greater portion of the present wires are fully occupied, the directors recommend to the shareholders that they should be authorised to exercise the borrowing powers provided by the articles of association, in order to undertake any new contracts that may appear desirable, as well as to provide for the requirements and efficiency of our own more immediate business.

The year 1862 offers every encouragement to this company, and if the same proportion of increase be continued as during the year 1861, there is no reason to fear the ultimate success of the undertaking.

Pursuant to the articles of association, three of the directors, Mr. Alderman Rose, Mr. George Sheward, and Mr. Robert Taylor, retire from the board, but being eligible, offer themselves for re-election. The auditors, Mr. Morris Chubb and Mr. Edward Sandell, likewise retire, and offer themselves for re-election.

London, 31*st January*, 1862.

Engineer's Report.

To the Directors of the London District Telegraph Company (Limited).

Gentlemen,—I have much pleasure in informing you that during the past half-year considerable progress has been made in the erection of special lines for private firms, the extension of wires to busy and important districts, together with the fitting up of several new offices, &c.

The new works completed comprise 13½ miles of line, carrying 27¾ miles wire, with ¼ mile of under-ground line and ½ mile wire. Cables have also been laid across the entrances of the Grand Surrey Canal (new basin), and the London Docks; these cables serve to provide for certain private lines, and at the same time afford a second and shorter route to the south-eastern districts.

Of the new lines erected nineteen have been completed, and instruments fitted, for the special use of private firms. In several instances short branch over-house communications have been led from your main lines, thereby utilizing the spare wires originally erected, and rendering them a profitable source of revenue.

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Fifteen additional offices have been provided with wires, fitted up with instruments, and opened for public traffic.

The repairs to one of your under-ground cables, alluded to in my last report, have been executed in a substantial manner. The whole of your under-ground lines continue in a satisfactory condition. The over-house wires are in good working order; and the entire system has been maintained in thorough efficiency.

The annexed table exhibits the number of miles of line and length of wire completed.

I have the honour to remain, gentlemen,
Your obedient servant,
EDWARD TYER.

Works Completed.

	Miles of line.	Miles of wire.
Total as per last report	78½	350
New underground	¼	½
„ overhouse	13¼	27¾
	92¼	378¼

RED SEA TELEGRAPH.

[From a Correspondent.]

The history of the Red Sea Telegraph Company, as detailed in evidence before the late Government Committee, presents a melancholy instance of those vicissitudes which attend, for a period, the early struggles of great and important discoveries and inventions. Our railway system for a time was involved in similar trials and vicissitudes. We can well recollect the wily "promulgators" of Capel Court and Bartholomew Lane during the railway madness of 1845, but the panic terminated the sway of our *adventurers*, and railways have since progressed steadily and satisfactorily. It is to be hoped that, like the Railway, our ocean Telegraphic enterprises will be freed from "*concessionaires*," and will ultimately assume that healthy aspect which alone leads to permanence and remunerative success.

The following account of the Red Sea Telegraph Company's monetary operations will be found interesting:—

It appears that on the 31st July, 1861, the total amount of capital realized by the Red Sea Company was £800,000, consisting of 40,000 shares of £20 each, and that the expenditure to that date amounted to £791,171 12s. 3d., leaving a balance of £8,828 7s. 9d. On the 31st July a balance of unexpended capital is shown consisting of the following sums:—

Unexponded capital	£8,828	7 9
Owing to the Company:—		
Unpaid dividends	6	9 5
Sundry creditors	3,032	15 9
	£11,867	12 2

Against the above amount the following accounts are credited:—

Balance at bankers on deposit ...	£4,591	11 1
Bank of Egypt	1,000	0 0
Agra Bank	400	0 0
In the hands of the General Superintendent and other officers of the Company	3,587	0 0
Amounts due from sundry on revenue account, &c.	2,289	1 1
	£11,867	12 2

A further account shows the amount of revenue received to 31st July, 1861, which consists of the following items, viz.:—

Amount of message money	£95	19 5
Ditto transfer fees	25	15 0
Ditto interest on loans	169	11 7
	£291	6 0

Against this sum the expenditure amounts to £14,431 4s. 6d.

The following are the particulars of the expenditure, viz.:—

Repairs of cable	£3,364	9	9
Inspection and maintenance of land line	249	8	3
Engineering charges	20	0	0
Advertisements, printing, stationery, &c.	73	1	2
Rent, office charges, medical attendance, postages, travelling and incidental expenses	1,079	10	1
Commission on remittances	194	14	5
Salaries and wages (London), including direction	1,609	16	0
Station salaries, wages, allowance for quarters, and travelling expenses	6,285	17	5
Mechanicians' department, instruments and batteries	324	2	3
Insurance of furniture, and SS. Telegraph	172	8	9
Law charges	863	14	8
Compensation (returned message-money)	194	1	9
	£14,431	4	6

Showing an—

Excess of working expenses beyond nett receipts on Revenue Account chargeable against capital, there being no Reserve Fund	£14,139	18	6

On the 31st January, 1862, the capital realized is represented at £800,000, and the expenditure at £795,345 3s. 6d., leaving a balance of £4,654 16s. 6d.

The balance sheet on the 31st January, 1861 stood as follows:—

Dr. *Cr.*

	£	s.	d.		£	s.	d.
Balance of Capital unexpended, as per statement	4,654	16	6	Balance at Bankers': Cash ... £1,465 14 11			
Amounts owing by the Company, viz.:—				Bill due, April 9th 4,719 16 0			
					6,185	10	11
Income Tax	700	0	0	Bank of Egypt	360	0	0
Peninsular and Oriental Company	1,904	14	10	In the hands of the General Superintendent, and other officers of the Company	116	18	11
Messrs. Freshfields and Newman	569	6	10	Amount due to the Company *re* Steamer Telegraph ...	1,166	8	4
	£7,828	18	2		£7,828	18	2

We now arrive at the concluding return entitled—

Dr. Revenue Account from 1st August, 1861, to 31st Jan. 1862. *Cr.*

EXPENDITURE.	£	s.	d.	RECEIPTS.	£	s.	d.
Compensation (returned message-money)	260	10	8	Amount of message-money	123	1	4
Repairs of Cable	11	14	7	„ Transfer fees ...	13	17	6
Inspection and maintenance of Land Line	211	18	3	„ Assets realised ...	5,278	6	9
Engineering charges ...	10	0	0	Excess of working expenses beyond nett receipts, or Revenue Account, chargeable against capital, there being no Reserve Fund	2,202	9	2
Printing, stationery, books, and advertisements ...	80	7	8				
Rent, office charges, postages, travelling and incidental expenses	498	9	3				
Commission on Remittances	137	4	11				
Salaries and wages (London), including direction ...	758	17	4				
Station salaries and wages, allowance for quarters and travelling expenses ...	5,043	9	6				
Mechanician's department, instruments, and batteries	75	15	9				
Law charges	574	6	10				
	£7,612	14	9		£7,612	14	9

(Signed) JOHN C. MARSHMAN, *Chairman.*

Examined and aproved, JERVOISE SMITH, ALEX. MACKENZIE, } *Auditors.*
11th February, 1162.

Examined and found correct,
(Signed) W. G. ANDERSON.
Treasurer.

It appears from the above accounts that the total amounts received for messages were—

From 1st February to 31st July, 1861 ...	£95	19	5
From 1st August to 31st January, 1862	123	1	4
	£219	0	9

On the other hand we find that the compensation or returned message-money amounted to £454 12s. 5d.

It is seldom that so enormous an expenditure of money has produced such a deplorable result, a result which it is to be feared the public will have long to bewail, in the shape of a heavy taxation o[f

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£40,000 for fifty years to come, and more especially so when a commission appointed by Her Majesty's Government to enquire into the causes of such melancholy failures has recently declared that such failures might have been to a great extent guarded against, or, indeed, altogether avoided. We quote the words of the Report:—"We desire, however, in conclusion to observe that we are clearly of opinion that the failure of the existing submarine lines, which we have described, have been due to causes which might have been guarded against had adequate preliminary investigation been made into the question."

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

Fine	2s. to 2s. 3d.	per lb.

INDIA RUBBER.

Fine Para	1s. 11d. to 2s.	per lb.
Negro	1s. 5d.	„
Java	1s. 5d. to 1s. 6d.	„

February 26, 1862. WM. KIRKMANN.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do. B. 7 per cent. till 1862	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
Stock	Electric Telegraph . .	100	96 to 99 xd	97½ xd
20	Red Sea and India Telegraph	all	19¼ to 19¾	——
1	Submarine Telegraph, scrip.	all	3/8 to ½	——
1	Do. registered . . .	all	3/8 to ½	——
10	Do. „ . . .	all	4 to 6	——
5	United Kingdom Telegraph.	2½	1½ to 0½ dis.	——
	Mediterranean Extension Tel.	all	4 to 5	——

Literary Notice.

THE YEAR-BOOK OF FACTS IN SCIENCE AND ART. By JOHN TIMBS, F.S.A. London: Lockwood and Co.

THE register of facts and events, furnished annually by Mr. Timbs, will be found not only an interesting popular exposition of scientific novelties, but also most useful for reference to those who are seriously engaged in various applications of science. In it will be found reproduced almost every paragraph which we might possibly have been able to transfer, during the past year, from the columns of English and foreign periodicals, into our own miscellaneous scrap-book. This, indeed, is no slight recommendation in regard to a work that does not aim at, or pretend to any degree of originality. The materials are arranged under the following headings:—Mechanical and Useful Arts, Natural Philosophy, Electrical Science, Chemical Science, Natural History, Zoology, Botany, Geology and Mineralogy, Astronomical and Meteorological Phenomena, to which is added an Obituary List.

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

THE CURRENT IN COILED CABLES.

To the Editor of THE ELECTRICIAN.

SIR,—I have to thank you for the insertion of my last letter.

I am happy to find it has attained the desired end. Unless false positions are assumed, there is a great difficulty in eliciting full and explicit information upon any subject. Had this not been done, the subject might have dropped.

I wish to thank Mr. F. C. Webb for his prompt reply, and am content to bear the ridicule of a "Telegraphist," if by so doing I have added but "a mite" towards the solution of the question. J. G. LT.

February 19, 1862.

SHEATHING OF SUBMARINE CABLES.

To the Editor of THE ELECTRICIAN.

SIR,—Without in the least disparaging the importance of a fair and courteous discussion in your columns as to the relative merits of the various insulating materials lately introduced into public notice, I am of opinion that the subject to which I now beg to call your readers attention, namely, that of the outer protective sheathing of submarine cables, is one of no less importance, and has not yet received that consideration in your columns which a practical telegraphist might have expected. It is well known that Her Majesty's Government, some two years ago, invited the attention of engineers, inventors, and manufacturers, to this subject, and that several parties responded thereto by transmitting to the Experimental Committee several specimens of sheathings adapted for shallow and deep sea telegraphic cables. Most, if not all cables, hitherto have been sheathed with spiral iron wires of various sizes, and we are informed that on several occasions it has been found that either owing to the eating up of the iron by corrosion, or kinks, which take place in submerging cables of this description, the insulation had been completely destroyed.

The several improved forms of cables submitted to experiment by the government, are described in page 126 of the ELECTRICIAN, and some of them appear to me exceedingly well adapted for the purpose of deep sea telegraphs, especially from the combination of light specific gravity and great strength. The following particularly struck me as possessing the necessary requirements of a submarine deep sea cable. Mr. Allan's, consisting of steel wires, laid spirally on a copper conductor, insulated in either gutta percha or india rubber, with an outer covering of plated jute, saturated with marine paint. Messrs. Hall and Wells, a sheath of longitudinal steel wires and hemp lines, kept in place with plated hemp saturated with stockholm tar, &c.; and Mr. De Bergue, a sheath of tarred hemp lines served round with cord of hemp. NEMO.

COPPER CONDUCTORS.

To the Editor of THE ELECTRICIAN.

SIR,—As there now appears to be a probability of a new cable being laid across the Atlantic, it is highly important that the conducting wire should be made of copper free from carbon.

Much has been advanced with respect to the best mode of insulating, but no notice appears to have been taken of the carbon in the copper conducting medium.

I find in testing a portion of the former Atlantic cable, that the conducting wire contains a larger quantity of carbon than is usually met with in the best copper wire.

It must be apparent to practical electricians, that greater resistance is offered to the passage of the current by a copper wire containing carbon than to a conducting medium manufactured from electro-deposited copper, which entirely frees it from carbon, and I should strongly recommend that in future, all submarine conducting wires be made of copper guaranteed free from carbon. The expense of obtaining it would be trifling compared with the advantage gained in so momentous an undertaking.

A cable made with pure conducting wire offers several advantages, viz., less battery power would be required to overcome the resistance, the size of the wire required would be five per cent. less—this would of course reduce the induction five per cent., and lastly, the electric current having a superior conducting medium to pass through, currents of such high tension would not be required, and there would be less escape through the insulating body. T. W. STEARS.

3, *George Street, Hull, Feb.* 24, 1862.

VOLTAIC BATTERIES.

To the Editor of THE ELECTRICIAN.

SIR,—As you were kind enough to give insertion to my last two letters, I have taken the liberty of addressing you again. I beg to thank you for your answer to my question, which was made more apparent by your lucid article on the "Induction Coil," which fully explains the action of the condenser. I promised to give a description of a cheap battery. The first is formed of a piece of wood 8 inches long and 4 wide, covered with resin varnish, and, before dry, covered well with powdered coke, this, before being used, is soaked well in nitric acid; it is to be used in the place of the platinized plate, in Smee's arrangement. This is surrounded by a plate of iron 12 inches by 6 broad; the sulphuric acid solution to be 1 part acid and 4 parts water. The next is one that may be used without a jar, and is very portable and very quickly made: a piece of thin zinc, 8 feet by 4 inches wide, covered with cloth to within one inch of the end, around this is wound either copper or iron wire from end to end, a piece of copper wire is soldered on to the uncovered portion of the zinc, the whole is then wound up on itself; it may be laid in a plate and the acid solution poured over it; this will give a strong current for some time, if the precaution is taken to wash it well after using. The only merit in this (if any) is, that a number of couples may be made very quickly and cheaply; the one described would cost about 8d., and is sufficiently powerful to work a coil machine; when it ceases to act, the copper wire may be used again with another strip of zinc. The next is one which will give powerful shocks: 30 or 40 pieces of zinc one inch by 2, covered with cloth, and each wound with copper wire, the copper of each joined to the zinc of the next, and so on; the whole suspended to pieces of glass rod fitted in two upright pieces of wood fixed in a board, taking care that the elements are all separated and hang in loops from the glass rod, the acid solution to be 1 part acid and 8 water; this will give shocks every time contact is made and broken, which may be done by arranging a small electro-magnet on the board which holds the uprights: to be well

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washed after using. This has some resemblance to "Pulvermacher's" chains, but was made by me in this form some time before hearing of these. I trust I am not trespassing on your kindness too much. You mention in your last number that you will refer again to the condenser, and I trust that something more may be said of the "Induction Coil" in your future numbers.—I am, sir, yours respectfully,

J. Cook.

P.S. I think I have now shown how amateurs may construct for themselves, with a little ingenuity, both batteries and a coil machine on very cheap and efficient principles, so that the expense cannot deter any one from prosecuting so delightful and wonderful a study as electricity.

Miscellanea.

Professor Secchi has published a memoir "On the Connection of Meteorological Phenomena and variations of the Intensity of Terrestrial Magnetism." He believes, "*that we must absolutely admit the mutual dependence of magnetic variations and meteorological variations.*" He adds, "The accuracy of the following principles is beyond doubt:—1. Every rupture of meteorological equilibrium, which produces a condensation or a rarefaction of vapours, produces a rupture of electrical eqilibrium. 2. The equilibrium of this agent can only be re-established by means of a current which discharges itself from place to place upon the surface of the earth. 3rd. This current cannot fail to act upon the magnetometers, and to be indicated by them." He gives thirteen pages of "Comparison of Magnetic and Meteorological Variations." He says, "It appears that there are two classes of disturbances: *auroral* disturbances, and the ordinary meteorological disturbances which are caused by *tempests.*" In this first essay upon this subject he says: "I protest that I do not pretend for a moment to establish definite laws; I will simply leave to the judgment of philosophers the task of deciding whether the proofs are sufficient or not." The phenomena which led him to suspect the relations in question are:—1. That the instruments are more disturbed in winter than in summer. 2. That the bifilar and the vertical force instruments vary much from the mean during bad weather. 3. The indications of these instruments increase greatly when cold and violent winds blow, even when the decinometer does not vary; the reverse with south winds. 4. The bilifar, from the delicacy of its construction, is sensible to all the small atmospheric variations; even when they are of short duration. He thinks that, "atmospheric electricity may eventually be revealed as the veritable and only principle upon which depend magnetic variations, which are still so mysterious in their origin." He has constructed an apparatus for measuring atmospheric electricity, which he "he has always found to be very intense during disturbances.—*Proceedings of the Meteorological Society.*

The Atlantic Telegraph.—Mr. Cyrus Field, whose well known exertions in connection with the late attempt to lay down a submarine line between England and America has lately arrived in this country with a view of renewing, if possible, the above project.

Renovating Porous Battery Jars.—The porous jars used in the Daniell battery are liable to become clogged by a deposition of metallic copper. This may be removed by slightly heating the vessels, and immersing them for some hours in nitric acid contained in a stoneware vessel. The following plan, based upon the conversion of copper into an oxychloride by the joint action of a compound of chlorine and of the atmospheric air, will, however, in most cases, be preferable. The jars are placed on the ground in the open air, and from time to time moistened with a dilute solution of common salt, to which may be added a little free muriatic acid. In a few days the copper deposited upon the jars, and within their pores, will be converted into a green compound of chlorine and oxide of copper, the same as that known in commerce under the name of Brunswick green. This compound may be removed by immersing the jars in muriatic acid; but this operation is not absolutely necessary, as the oxychloride of copper, though insoluble in water, does not destroy the porosity of the vessels.

The Crystallization of Carbon.—It appears that this problem—which is no less than that of the artificial production of the diamond, has on several occasions been solved by the application of electricity and chemical science; though it should be stated that the samples obtained of the precious gem were in most cases extremely minute. The most celebrated experiment, in which a product possessing all the properties of the diamond was obtained, is perhaps that of M. Despretz, described in Du Moncel's *Notice sur l'appareil d' Induction Electrique.* M. Despretz attached to one of the terminals of the secondary wire of the induction coil a small fragment of sugar-candy, in which pure carbon exists in combination with the elements of water; the other terminal carrying a small portion of platinum wire twisted into a coil. The terminals were fixed within an exhausted glass vessel, and the induction coil arranged so as to transmit a succession of currents in the direction from the carbon compound to the platinum wire. The machine having been uninterruptedly kept in action for more than a month, the platinum wire was found to have become covered with a black deposit, in which several minute crystals were distinguishable, some of which were black, and others perfectly transparent. These crystals were submitted to the examination of M. Gaudin, a distinguished lapidary of Paris, who found them to possess all the characters of the natural diamond. A portion of them in powder was used for polishing several rubies; a very short space of time being found sufficient for this purpose. Another portion was burnt, without leaving appreciable residue. The following notice of some other experiments with the same object in view is taken from the *London Review*:—"The production of elementary substances in the crystalline state is not by any means difficult; a few bodies indeed, carbon amongst the number, have long resisted chemical persuasion, but these have gradually yielded themselves to crystalline influences, until carbon now stands alone. Its two elementary brethren, silicon and boron, are amongst the latest triumphs in this respect, and the exact similarity in physical properties which is observable between the artificial boron and silicon-diamonds and the natural carbon-diamond, shows that philosophers are at last upon the right track, and that any moment may place the fortunate chemist in possession of a discovery rivalling in commercial value that of the long-coveted philosopher's stone. Meantime rumours of the actual solution of the problem are beginning to be heard. Mr. J. Joyce imagined some time ago that he had obtained carbon in the crystalline form, by the action of electricity upon a mixture of carbonic acid and hydrogen. M. Cagniard de la Tour thought that he had obtained some crystals of diamond by fusion, and M. Despretz by the action of electricity upon certain compounds of carbon. But by far the most important result is one just made known by M. Rossi, of Toulon. The experiment was performed by M. Gannal, and consisted in the action of phosphorus, water, and bisulphide of carbon upon each other for several months. Crystals (twenty in number) were thus obtained, which were found to have all the properties of diamond. They were so hard, that no metal would act upon them; they even scratched steel; they were perfectly transparent, and had extraordinary brilliancy; and finally, some of the best formed of them had crystallized in dodecahedra, the crystalline form which is characteristic of the diamond."

Mr. S. Alfred Varley has retired from the post of Engineering Superintendent of the Metropolitan District, in the service of the Electric and International Telegraph Company, and has entered into partnership with his father (Mr. Cornelius Varley), as telegraphic and scientific instrument manufacturer.

To Correspondents.

H. (Haverfordwest.)—Books on electricity can be had of the following libraries:—Mr. Spon, 16, Bucklersbury, E.C.; Messrs. Hebert, Cheapside, and Mr. Atcherley, Piccadilly.

W. Johnson.—The following is a description of a very powerful electro-magnet constructed for Dr. Faraday:—The power of the electro-magnet varies with the size of the iron cylinders, with the intensity of the currents, and with the length and thickness of the copper wire. With regard to the thickness of the iron bar, the power of the electro-magnet to deflect a magnetic needle, has been found by Dub to be proportional to the square root of the diameter of the cylinder, and its lifting power in proportion to its simple diameter. Instead of coiling the wire round the bobbin in one continuous length, which is known to diminish considerably the influence of the current, it is better that the total length of wire intended to be used should be cut into several portions, each of which covered with silk or cotton, should be coiled separately on the iron; the ends of all the wires are then collected into two separate parcels, and a steel bar placed in the coil between them, and made to communicate with the battery, care being taken that the current shall pass along each wire in the same direction. A powerful bar electro-magnet was constructed some years ago under the direction of Mr. Faraday, for the magnetic Observatory at Greenwich. The helix was 27 inches long by 2⅜ inches internal diameter; it had four coils of No, 7 copper wire covered with tape, their lengths being 108 feet 10 inches, 120 feet, 129 feet 7 inches, and 143 feet, in all 501 feet 5 inches; and they were arranged with bars and clamps so as to admit of using one or more of the helices variously combined. The soft iron core was 28 inches long, by 2⅜ inches in diameter, and there were two other cores each 12½ inches by 2⅜ inches for magnetizing. Another powerful magnet designed by Mr. R. Roberts, C.E. This magnet is 2⅛ inches thick, and 6⅜ inches square on its face, into which are planed (at equal distances from each other across the surface) 4 groves 1¼ inch deep, and nearly ⅜ of an inch broad. Into these grooves was coiled, three-fold deep, a bundle of 36 copper wires (No. 18), wrapped with cotton tape, to prevent contact with the iron, the wires having no insulation from each other. The magnet, with the conducting wire, weighed 35 lbs. The armature was 1½ inch thick, and the same size as the magnet on the face: its weight was 23 lbs. The upper side of the iron, which constituted the magnet, was formed into an eye, or bow, by which the whole was suspended; and a similar bow was formed on the back of the armature to which the weight scale was attached. This electro-magnet, when excited by a battery of 8 pairs of Sturgeon's cast-iron jars, is reported to have sustained the enormous weight of 2,950 lbs.

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The Electrician.

Vol. I. No. 18.—March 7, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 195.]

72. By the success which has hitherto attended our doctrines, derived at first by merely relieving electrical theory of some of its superfluities, we may learn how great evil may be done by adding to the truth; on the other hand we may conceive it to be equally mischievous to divest it of any of its belongings, for if it be incomplete it must needs be insufficient, and prove itself to be so by sooner or later breaking down. We believe our theory to be founded on truth, and though we cannot venture to say we are acquainted with all its parts, it behoves us not to omit from our account of it any of its hitherto discovered principles; and we have now to point attention to one of some moment, as it will be at the basis of much that we shall have to refer to.

73. We shall find it very conducive to an exact representation of our meaning if we make use of two terms, already introduced by Professor Faraday, giving to them however a somewhat modified and more specific application; we mean the words *inductric* and *inducteous*, which have the recommendation of being expressive and also easily remembered.

74. We propose to call an *electrical charge* inducteous with relation to any electrical charge by which it has been induced; and we shall designate the same or any other electrical charge inductric with reference to any electrical charge induced by it. These definitions will leave us free to continue to the adjective *inductive* and the noun *induction* their own commonly understood and general significations.

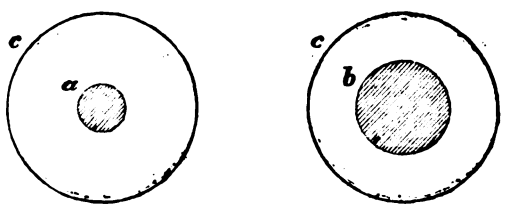
75. The following application of our two adopted terms will illustrate their usefulness. Each of the aërial particles, or units of air, in an atmosphere sustaining static induction, must needs be, according to the theory we are expounding, the seat of two distinct acts of electrical force of unequal intensities, one exerted by its common matter, and the other by its natural electricity. One of these actions is inducteous, and in its character of an effect may be regarded as *looking backward to its cause*; the other is inductric, and in its character of a cause may be considered as *looking forward to its effect*. Or, to put the case perhaps more precisely, each aërial particle to which inductive action extends will have an inducteous electrical charge either plus or minus, which, acting upon other aërial particles will be to them an inductric charge of smaller intensity. The difference between these two intensities co-existing in the same particle of aërial matter (owing its existence to the definite nature of the electrical attraction and the electrical law of quantity), supplies, as we shall soon understand, an intelligible cause for the phenomena into which we are about to inquire.

76. With respect to the above terms it only remains to be said that whenever a plus charge is acting inductively on a surrounding atmosphere, the common matter of the air as far as the action extends will be inducteously charged, and the natural electricity of the air inductrically charged. On the contrary, if the charge which originates the induction be a minus one, then the natural electricity of the surrounding air will have the inducteous, and its common matter the inductive charge.

77. For sake of perspicuity, we began to elucidate our theory of static induction, by considering this action as being propagated outward in all directions from a mathematical point surrounded by air; in practice, we have to do sometimes with material points, which may be regarded as spheres of very small size, and sometimes with spheres of larger magnitudes. Now if the student steadily bear in mind that the quantity of inductive atmosphere is always a constant quantity at any given distance from a central point, whether anything or nothing intervene, and also that the inductive action originated by a given plus charge, and arriving at any particular distance from the centre, is the same, whether it have started from that centre, or from some intermediate spherical surface, he will understand that what we have been saying about points applies equally to conducting spheres of all magnitudes, provided only we make the calculations always start from points in their centres.

78. Now, remark! it must be inferred from these principles, that all spheres, however much they differ in size, will have upon their surfaces, under any given intensity, equal quantities of electricity; but that, as we know by observation, is not true in fact. Is, then, the theory faulty, or has it other true principles needing to be taken into account? If the latter, we ought soon to discover them by following out our reasoning; let us see whether we can do so.

Fig. 5.



79. Let *a*, in the preceding figure, be a conducting ball one-half the diameter of another conducting ball *b*, and consequently with a surface one-fourth part as large; and let the two be supposed to contain equal quantities of plus electricity, the intensities of the two charges dying away to insensibility at some distance, *c c*, from the centres equal in the two cases. In this, which is the state of things supposed by the theory, so far as it has yet been considered, will any of the plus charge of *a* tend to pass into *b*, on the supposition that opportunity were offered? We know it will do so in fact; but has the theory any way of accounting for the fact on exact mechanical principles? It has; because, as the inductive aërial envelope on which the charge of *b begins* its attractive action contains four times as many aërial particles for it to diffuse itself among as the inductive envelope on which the charge of *a begins* to act; and as also the charges of *b* and *a* are equal; it follows, from the electrical law of quantity, that the reaction opposed to the setting up of induction from the surface of *a*, will be 16 times greater than is opposed to the setting up of induction from the surface of *b*. Therefore, if an opportunity be offered, say by the temporary interposition of a conducting wire *w*, Fig. 6, electricity will pass from *a* into *b*, until their respective quantities be so proportionate that the inductive action setting out from their surfaces shall be equally opposed by reaction at every step of its progress, even up to the place where it becomes lost to sense in the distance.

80. Now, in order for that equality to reign throughout the whole of the inductive atmospheres of *a* and *b*, it is necessary that the induction shall become diffused with the same rate of speed in the two cases; that is to say, starting from points on each of the conductors, it shall in both instances, at equal distances from those points, be diffused over equal aërial surfaces; from which it follows, that the extreme distance to which the

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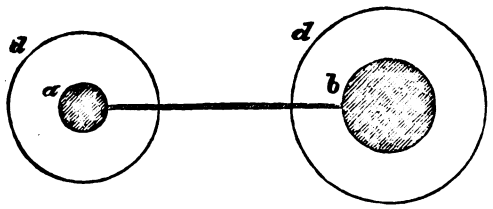
induction extends from all starting points may be denoted by two spherical surfaces, concentric with the conducting spheres *a* and *b*, and at equal distances from their surfaces respectively. In Fig. 6, those spherical surfaces are represented by the circles

Fig. 6.



d d; and we have only to imagine them to be geometrically occupied by the greatest possible number of equal pyramids (68), their bases coalescing, and their vertices resting on the conducting surfaces, to represent the total number of units of electrical charge around *a* and *b* respectively. The pyramids may, of course, be of any altitude and number of sides, the only necessary condition being, that in all of them equal areas shall be exposed by sections made at equal distances from their vertices.

81. From these conclusions, obviously flowing from our theory, we obtain the following rules for our guidance in practice:—1st. Conducting spheres of unequal diameters, charged, and put into communication with each other, under circumstances that prevent their interference with each others inductive atmospheres, propagate outwards an inductive action that becomes of any given intensity, or sinks away into insensibility, at equal distances from their surfaces respectively. 2nd. The quantities of electrical charge on unequal conducting spheres freely surrounded by the atmosphere, and all of equal intensity, are relatively denoted by the measures of spherical surfaces of air, to which the induction under any given degree of intensity extends, and which aerial surfaces in all the cases are at equal distances from the conducting surfaces.

82. If the preceding rules be well founded they ought to be susceptible of experimental verification; for example, the latter of the two would suggest to us a way of placing a conducting sphere in the atmosphere under circumstances which preclude its having any electrical charge whatever; and the former admits also of very simple illustration, as we shall now see.

83. Prepare an insulated conductor similar to the three former ones (35) but much smaller, the ball may be about 1¼ inches diameter, and of brass; its centre is to stand at the same altitude as the centres of the larger ones, and its foot must be so formed that its surface upon occasion may be placed in contact with two of the larger spherical surfaces at the same time. It should be perforated at its opposite sides by some fine holes for receiving points of connecting wires.

84. And here we shall also want a ready and sensitive means for detecting the presence of minute electrical charges; and we will take this opportunity of describing the gold-leaf electrometer, which, when well made, is perhaps the best of such instruments for general purposes. We will describe our mode of constructing it. We take a wide and short lamp-glass, like that used for the discharging electrometer (32), quite clean, and cement it below into a mahogany foot, and above into a cap of the same material, the centre of each being perforated by a large hole about an inch in diameter. The upper hole is fitted with a wooden plug, turned with a shoulder against which it rests upon the cap with a slight amount of friction; through this plug is passed a glass tube, four inches long, and three-eighths of an inch diameter, varnished inside and out, and having a stout brass wire, five inches in length, secured in its axis by a plug of silk twisted round the middle of the wire, and made unyielding with some resinous cement, a clear space being left everywhere else between it and the glass. The upper end of the wire is tapped through the hemispherical top of a short cylinder of brass, that serves as a hood to protect the interior of the tube from dust; and it carries at its summit, sometimes a precisely similar piece reversed, to answer the purpose of a cup, or to support a small table, or sometimes in its place a brass ball. The lower end of the wire, destined to carry the gold-leaves, has received a saw cut, so as to admit of being lightly closed upon two slips of thick *gold-paper*, one-quarter inch long, and one-eighth inch wide. These slips being introduced, and the wire closed upon them, but only so loosely as to allow of their being afterwards adjusted, the only thing remaining to be done is the suspension from them of the gold-leaves; to do this we expose a square of gold on the paper leaf of its book, and then, with a common steel knife, quite dry and with a smooth keen edge, using only a gentle pressure, and a very slight backward and forward motion, the book itself serving as a cushion, we cut the *gold only* into three pieces, leaving a middle slip something less than an inch wide. One end of the slip being then carefully cut straight, and the spare pieces removed out of the way, we proceed to cut from it two strips about one-eighth of an inch wide, which we then separate to a little distance from each other, and also from the main piece. This requires considerable care, if not some experience; as also will the suspension of the leaves, which we shall do better not to attempt, if we have either cut the paper, left any part of the gold uncut, or split or crumpled up its edges —in either of which cases we should abandon the leaves, and make fresh ones. Having the two pieces of gold-leaf, about an inch long and one-eighth wide, lying flat and detached on its own book, we make the ends of the slips of gold paper on their outer sides clammy with a little paste, and then, holding the plug and wire firmly, we present it horizontally in such a manner that by a gentle downward pressure the under slip of paper is made to take up by its near end one of the two leaves. Next, turning the whole over so that the other slip of paper may be undermost, we lay one gold leaf carefully upon the other, and take the second up by its end as we did the first. When the plug is restored to its proper place, the two gold leaves should hang face to face, vertically and perfectly parallel; but if they do not, they may be first set right by a little adjustment of the paper slips with the point of a needle, and then secured in position by a particle of paste laid about the cut in the wire. When properly finished, the two gold leaves should separate to an angle of nearly one hundred and twenty degrees by the mere approach of a piece of sealing wax or vulcanite, slightly rubbed against woollen cloth, and fall absolutely parallel again on its removal.

85. A gold-leaf electrometer thus prepared is more delicate, and incomparably more enduring, than the ordinary ones which have leaves three or four inches long and proportionately wide; but, in common with them, it is liable to mislead us, in consequence of electrical charges soon becoming deposited upon the inner surface of the glass. The present form of instrument, however, enables us very easily to get rid of such charges, which we may do at any time by removing the wooden plug with its appendages into a place of safety, while we pass through the cylinder vapours from a small flame held for a few seconds under the large hole in its foot; the alternate application of the vapours externally and internally may in some instances be desirable. We will now employ this instrument for verifying the rules just afforded by our theory (81, 82).

Exp. 15. Place one of the large insulated conducting spheres (35) and also the smaller one just described (83) upon a table; connect them temporarily by a long wire, and then, by means of a discharging rod, communicate to them from the positive conductor of the revolving machine an electrical charge. Having fitted the summit of the gold-leaf electrometer with its surmounting ball, into which the lower end of a vertical wire has been screwed, its upper end being somewhat more elevated than the centres of the spherical conductors, let their connecting wire fall away, and introduce midway between them the vertical wire

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rising from the electrometer. In the next place slide towards the electrometer either of the charged spheres until it be near enough to produce the slightest observable deflection of the gold leaves; and then push forward the other charged conductor until the deflection of the leaves just commences to be increased. On now measuring the distances of the two spherical surfaces whose intensities had to be compared it will be found that the wire of the electrometer is exactly midway between them.

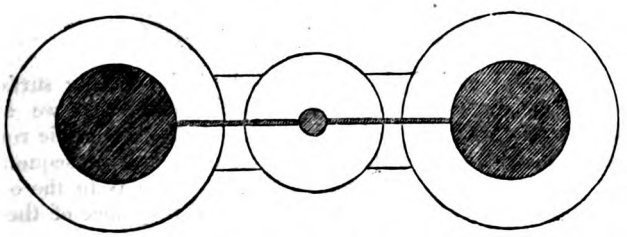
This experiment demonstrates the truthfulness of our first rule; we may now proceed to prove the second true likewise.

Exp. 16. Place two of the large insulated spheres (35) upon a table with the smaller one (83) between and in contact with both of them, all their centres being in the same straight line. Transfer to one of the outer spheres a plus charge, by connecting it for a moment by means of the discharging rod (34) with the positive conductor of the revolving machine. Remove the two larger spheres from the smaller one by drawing them simultaneously and quickly in opposite directions. We shall find an electrical charge in each of the large conductors great enough to attract the upper disc of the Balance Electrometer if a proper trial be made; but the middle and smaller ball will be so free from charge that by its contact with the top of the delicate instrument just described (84), it will cause its two gold leaves to diverge either not at all or only to a very small degree, though the charge of one of the larger balls must evidently have passed through the small one in its way to the other side.

Exp. 17. Reinstate the three spheres in position, but instead of the middle and smaller one being in actual contact with the two larger ones, make it communicate with each of them by a wire six inches long, pointed at both ends, and just reaching from one to the other. By means of the discharging rod transfer to one of the large balls a plus charge, as in the preceding experiment; and draw away the outer balls as before, allowing the two wires to fall. It will now be found on making trial that each of the three conductors will be in possession of a considerable plus charge.

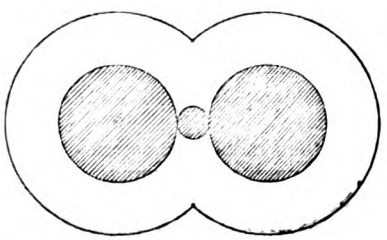
80. Now, why did the plus electricity distribute itself over the small middle ball in one of these cases and not in the other? A satisfactory answer will be conveyed by a mere glance at the two figures 7 and 8. In the former, which represents the theo-

Fig. 7.



retical conditions of Exp. 17, we have an equal thickness of aërial envelope around all the balls, conferring upon each of them a capacity for electrical charge represented relatively by the surface of its inductive atmosphere; whereas in fig. 8, in which the

Fig. 8.



conditions of Exp. 16 are delineated, the small conducting ball in the middle has no inductive atmosphere, and consequently no capacity for charge. We shall have something more to say about the latter figure at a subsequent time.

81. We are decidedly averse to the introduction of new names into electrical science, for we have seen that though they may be in the abstract learnedly faultless, they are too often of a character not to win universal adoption; and, only sharing it with some others they were meant to supercede, they have made what already was confusion, "worse confounded." But it sometimes occurs that we are presented with a leading idea to which we may have frequent need to refer; and for which, it being new, there may not be a fit technical expression already in use. In such a case we should be remiss if we did not attempt to supply the deficiency. We have introduced into theory for the first time a definite electrical attraction and a law of electrical force, by the coincidence of which we have been able to conceive that plus electricity, cut off by insulation from the common matter to which it naturally belongs, attracts other common matter that is around it, virtually setting free electricity pent up by insulation within it, to act in its turn upon a precisely equal quantity of other foreign common matter, thus originating an inductive action to be propagated outwards, absolutely without any loss in its quantity, until it becomes so reduced in intensity as to be no longer appreciable. In this apparent extinction of electrical attraction we have a substitute for the normal static equilibrium, lulling to rest a gigantic power that has become temporarily diverted from its peaceful functions, until means be opened for its returning again to their performance. If this state of things be a part of true electrical theory we shall want a term to express it; and we think that both the learned and the unlearned may consent to speak of it as the *artificial electrical equilibrium.*

(*To be continued.*)

ATLANTIC TELEGRAPH.

From the period when the results of the Government telegraphic inquiry first became known, it has been evident that the laying of a new Atlantic cable is merely a matter of time and opportunity. There are few whose opinion is worth having, who still deny the commercial practicability of a transatlantic line of telegraph, and fewer still who shake their heads at its feasibility in a scientific point of view. The time and the opportunity now appear to have arrived. A despatch has been forwarded by the Federal Government of America to their minister, Mr. Adams, requesting him to apply to the British Government through the Foreign Office, and placing the question upon such grounds as to render it well nigh impossible that this magnificent enterprise should be much longer delayed. Indeed, this invitation from our cousins in North America gives us an example to follow which we could scarcely decline, without tarnishing our fair name as champions of progress and civilization. It is a challenge worthy of our present advancement, and which should be answered with at least equal alacrity as that which calls for—

"The proud control of fierce and bloody war,"

and which has for its object the mutual interchange of amenities which throw two nations back, some fifty or a hundred years, into what some of us love to designate as the "good old times."

The information which has reached the public respecting the despatch in question is somewhat imperfect and inaccurate; and we therefore hasten to give its full purport to our readers. The offer from the Federal Government is to co-operate on equal grounds with England in the measures which may be found necessary to establish the transatlantic line, and to secure its safety and permanence. Nothing is mentioned in the despatch respecting the amount of the guarantee, or in relation to any other mode under which it may be proposed to raise capital; but this, with most other matters, is left to the discretion of our authorities. It is admitted that evidence and experience appear to favour a line laid in the route of the old cable, and consequently touching upon British soil alone, but the choice of a route is left entirely

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with ourselves, it being stipulated that in peace or in war the line should be available for both nations, and by both be held inviolate.

It appears almost idle to refer to the great advantages which would accrue to this country from its union by telegraph with the New World. Among the most immediate are the increased facilities which would be afforded in the transaction of business by our public departments. The telegraph would enable the War Office to diminish considerably the number of troops in our American colonies, and to direct their movements so as to increase their efficiency. The same may be said in respect to the Admiralty and the British fleet in American waters; and the submarine wire joining the two great systems of telegraph in the Eastern and Western hemispheres would be of at least equal importance to the Foreign Department of our Government. But it is in regard to the commercial relations between England and America that the value of the proposed telegraph is most manifest. By the shipping interest especially the Atlantic Telegraph is looked forward to as a means to enable the owners to have greater control over their vessels than they now possess, and, in great degree, directly to transact their business in America from our own commercial capitals.

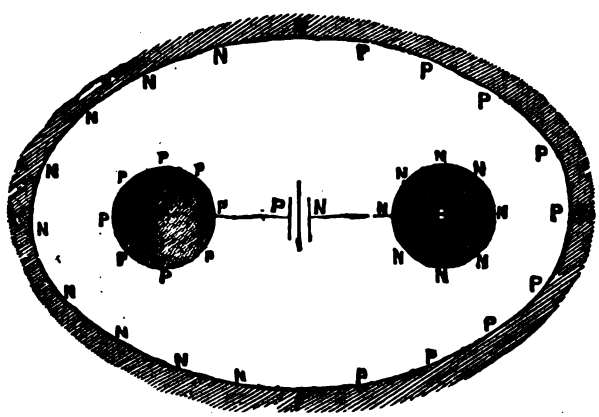
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 197.]

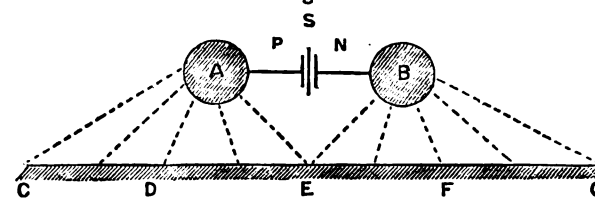
LET now A and B (Fig. 15) represent two conductors in connection with the opposite poles of a source, and surrounded by a conducting surface C D E F.

Fig. 15.



A compound inductive circuit will thus be formed; one, directly between the two conductors, A and B, which I will call the *direct* circuit; and the other, from one conductor, A, to the surrounding conducting surface, and back to the other conductor, B, which I will term the *indirect* circuit. If now B be connected to the outer conducting surface, that part of its charge which was caused by the indirect circuit will be neutralized by recombination with the opposite induced electricity on the outer opposing surface, leaving on B only the quantity produced in the direct circuit between A and B. B now forms simply a part of the outer opposing surface. The outer surface being now in conductive connection with the N pole, the inductive action takes place direct from A to the surrounding surface, and has in no part to cross the dielectric twice. The inductive resistance of what was, previously to B being connected to E, the indirect circuit will now therefore be halved, and double the quantity can, with the same source, be accumulated on those parts of the surfaces of the conductor A through which the indirect circuit passed. If the conductors are situated in the open air, then, even supposing the inductive action to go on simply to the surface of the earth in straight lines, the same arguments will hold good, for connecting one of the conductors to the earth will, in the same way, halve the resistance of the indirect inductive circuit. Thus, if A and B (fig. 37) be two conductors attached to the two poles of a source S, and insulated from the

Fig. 37.



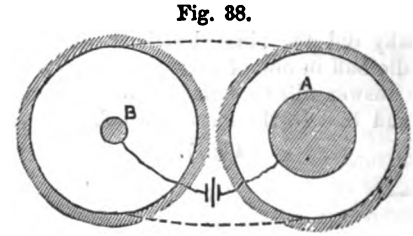
surface of the earth C D E F G, then the inductive circuit wil take place from P to A, and from A through innumerable paths to C D E, and from E F G to B, and thence to N.

By connecting A to earth, we evidently halve the resistance of this indirect inductive circuit, and double the quantity can, with the same source, be accumulated on those parts of B which are situated in the indirect inductive circuit, the quantity on that part of B which was charged by direct induction to A remaining unaltered.

We see here the reason why, if the rubber of an electrical machine be connected to the surrounding objects, or in fact to earth, we obtain nearly double the total accumulation on the prime conductor to that which we obtain if the rubber is insulated. This is supposing the surface of the rubber to be equal to that of the prime conductor, and as far removed as the prime conductor from surrounding objects. If, however, the rubber is (as is generally the case) smaller than the prime conductor, then it will be seen the inductive resistance is more than halved by connecting the rubber to the earth.

To make this clear, suppose B (fig. 38) to be the rubber, and A the prime conductor; and let it first be supposed that both of these

Fig. 38.



are surrounded entirely by separate spherical opposing surfaces of equal diameter. Then it is evident, from what we have already stated, that the resistance of the shell of dielectric round B has greater resistance than that around A, and consequently, when we destroy that around B, by connecting B to the outer opposing surface, we shall reduce the total resistance of the inductive circuit to less than half. If, instead of thus being surrounded by separate surrounding surfaces, they be surrounded by a common opposing surface, as shown by the dotted lines, the case will only be modified, and the same arguments apply, except that whatever inductive action takes place *directly* between them remains unaltered, the same as in the case when the conductors are of equal size. We see, therefore, that to explain the difference in the effect produced by connecting the rubber to the surrounding objects or to earth, there is no occasion to have recourse to the "comparatively infinite size of the earth," but that the above explanations will hold equally well for experiments performed in an insulated room.

If nearly all the inductive action takes place directly between the two conductors connected to the two poles of a source, then the resistance of the whole of the inductive circuits will not be much reduced by connecting one conductor to the outer opposing surface; or, in other words, if the resistance of the direct inductive circuit is very small compared to the indirect circuit, the total accumulation will not be

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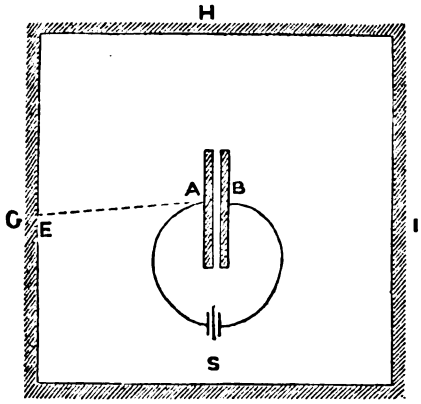
much increased by halving the latter circuit. Thus let A and B (fig. 39) be two metallic plates close to one another, and each connected to the opposite poles of a source S; and let the outer

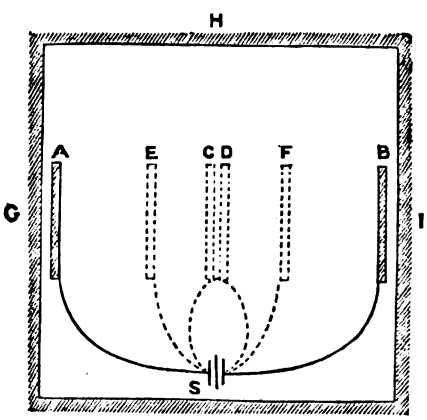
Fig. 39.



opposing surface, G H I, be situated at a considerable distance from the plates. There will then exist, as in other cases described, two inductive circuits, the one passing direct between the plates, the other passing from either plate to the outer opposing surface, and from thence back to the other plate. But it is evident the resistance of the direct circuit between the plates is very much less than that from A or B to the surrounding conductors, and back to the other, and consequently the principal accumulation will be on the interior surface of the plates. If one of them, A, be connected by a conductor, A E, to the surrounding surface, then this will halve the inductive resistance of the indirect circuit, but will not affect the direct circuit, which remains the same, the total quantity accumulated will, therefore, be but little altered.

If the inductive action from the conductors connected to the two poles of a source goes on principally to the common surrounding surface, then the total accumulation on one conductor will be nearly doubled by connecting the other to the surrounding conducting surface. If A and B (fig. 40) represent two plates as before, attached to a source, and placed each close to the

Fig. 40.



opposite parts of the surrounding conductor, G H I, then in this position the sum of the resistances between the plates and the surrounding surface, (or in fact the resistance of the indirect circuit,) will be much less than the resistance between the two plates themselves, or the direct circuit, and consequently nearly all the accumulation, will take place on their surfaces proximate to the surrounding surface, G H I. If now, one plate, A, be joined to the surrounding surface, the resistance of the indirect circuit will be halved, and double the accumulation will take place on those parts of the other plate, B, which are situated in the indirect circuit.

In the case, therefore, of the two conductors insulated from the surrounding surface, and attached to the two poles of a source, the inductive action goes on we see in two circuits, the one direct between them, and the other indirect through the action on the common opposing surface. We can decrease the resistance of either of these circuits by an alteration in the position of the conductors; and we can decrease the resistance of one circuit by such an alteration of position that this will at the same time increase the resistance of the other. For instance, if in fig. 40 we approach the plates A and B towards one another to the position C and D, we decrease the resistance of the direct circuit, whilst we increase the resistance of the indirect circuit, and the accumulation will be the greatest on their proximate sides. If placed at A and B, we decrease the resistance of the indirect circuit, whilst we increase the resistance of the direct circuit, the accumulation will therefore be greatest on their sides nearest to the outer conducting surface. It follows, therefore, that at some position the sum of the resistances of *both* circuits will be at their maximum. For instance, if placed at some position, E and F, both circuits would be offering considerable resistance, and the total accumulation on the plates would be at its minimum.

(*To be continued.*)

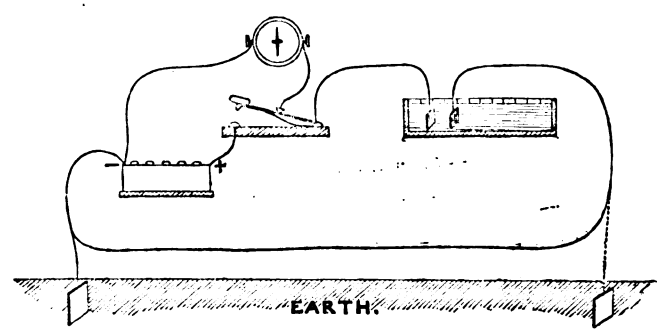
ELECTRO-POLARIZATION.

BY W. H. PREECE, ASSOC. INST. C.E.

[Continued from page 199.)

The following experiments were undertaken to arrive more clearly at the laws which regulate the evolution of these "gas currents." The arrangement adopted is shown in the accompanying figure.

Fig. 1.



The galvanometer employed was a delicate vertical needle, hung on jewels, surrounded with No. 35 wire, giving a resistance of 17 of Varley's units (one mile of No. 16 copper wire), and showing 70° with one cell. The battery was Muirhead's improved Daniell's, in excellent condition, every cell being carefully equalized in tension and resistance. The key was of the ordinary description. The trough, containing the electrolyte, was 12 inches long, 6 inches broad, and 6 inches deep. It had a graduated scale to which the electrodes were fixed. The return wire was used in place of the earth, lest tertiary effects might interfere with the correctness of the results. The connecting wires were gutta percha covered copper wires. All the results detailed are the mean of 5 observations. The plates were carefully cleaned after each observation. 10 cells, unless otherwise specified, were always used.

Experiment 1.—*The Effect of increasing Battery Power:*—Two copper electrodes, of one square inch area, were placed in the

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trough (filled with pure distilled water), one inch apart. Duration of contact, 10 seconds.

Cells.		Duration of Gas Current.
10	60°	60 seconds
9	60	80 „
8	60	75 „
7	60	75 „
6	60	70 „
5	60	60 „
4	50	25 „
3	45	15 „
2	30	10 „
1	25	5 „
100	60	70 „

It therefore appears that for one square inch surface exposed, the maximum result is attained with 5 cells, and that the effect remains constant with all powers above that number. It is probable that this varies with the extent of surface exposed. Some experiments were made to test this point, but the details were unfortunately mislaid, and I have not been able, up to the present moment, to repeat them. The results showed, that with double and treble the surface, the maximum effect was produced with very nearly the same proportionate increased number of cells. The duration of the gas current is proportionate to its energy.

Experiment 2.—*Effect of Duration of Contact :—*

1 second	5°	with one cell.
2 „	7	„
5 „	10	„
20 „	25	„
30 „	32	„
60 „	35	„
120 „	35	„

The maximum effect is therefore produced with a current of one minute duration, which, unless otherwise named, was the period of contact adopted in the subsequent experiments. It would however appear, on examining experiments 1 and 5, that this maximum effect is reached more rapidly with higher powers. With 100 cells, it was attained in 2 seconds.

Experiment 3.—*Effect of Increasing Resistance of Electrolyte:—*

Electrodes	1	inch apart	60°
„	2	„	50
„	3	„	40
„	4	„	35
„	5	„	30
„	6	„	25
„	7	„	22
„	8	„	20
„	9	„	18
„	10	„	15
„	11	„	18
„	12	„	10

The currents therefore decrease inversely as the resistance of the electrolyte.

Experiment 4.—*Effect of Increasing Surface of Electrode :—*

First.—Two wire ends, about ·2 square inches area; 80° not variable with duration of contact.

Second.—One square inch opposed by nine square inches; 7° variable with duration of contact.

Third.—Nine square inches opposed by one square inch; 3° variable.

Fourth.—Both nine square inches; 5° variable.

Fifth.—Both one square inch; 60° variable.

Experiment 5.*—*Effect of Increasing Duration of Contact and Area of Surface simultaneously :—*

	Five Seconds.	Ten Seconds.	Twenty Seconds.
One square inch	40°	48°	58°
Two „ „	25	45	47
Three „ „	8	25	45

Showing that effect is the same if we increase area of surface and duration of contact simultaneously.

Experiment 6.—*Effect of Changing Nature of Electrode :—*

Zinc, one square inch	12°
Lead „ „	17
Iron „ „	35
Brass „ „	60
Copper „ „	60
Platinum „ „	70

*Experiment was performed on a subsequent day, when the power of the battery declined.

Showing that the effect varies with the affinity of the metal for oxygen.

Experiment 7.—*Effect of varying Electrodes and Electrolyte :—*

	Copper.	Zinc.	Platinum.
Pure water	60°	12°	70°
Sulph. acid (diluted)	12	0	90
Sulph. copper	5	5	60
Sulph. zinc	90	8	90

Showing, as before, that it varies with the chemical affinity of the disengaged element for the metal of the electrode.

In the following experiments the return wire was abandoned, and the earth plates used; *vide* Fig. 1.

Experiment 8.—*Measurement of Electro-motive Force :—*

Gas current, copper electrodes, through 5 units = 85°.
One Daniell's cell, through 50 units = 85°.
Therefore, by Ohm's law, (resistance of galvanometer being 17 units):
Tension of one cell (E) : tension of gas current (E') : : 67 : 22,
Or making standard cell = 100.
Negative gas current = 32·9.
Positive gas current, similarly shown to be = 29·33.
Platinum electrodes :—
Negative gas current = 51.6.
Positive „ = 38·28.

Experiment 9.—*Difference of Positive and Negative Primary Currents*—one cell, one minute :—

Positive primary	36°	25 seconds	duration.
Negative primary	28	25 „	„

Showing that, while the tension varied with the nature of the primary current, the duration was the same.

Experiment 10.—Terminals of various patterns and sizes—plates of zinc, copper, and iron—masses of brass and various metals were interposed in place of the trough and electrodes, and varying powers from 1 to 200 cells employed; but no trace of these or any reactive currents could be produced.

It follows, from the preceding experiments, that the phenomenon of gas currents is one peculiar to small surfaces, continuous currents of considerable duration, and short circuits; and that as we increase the area of the surface of the electrode, and the resistance of the circuit interposed, while we decrease the duration of the currents, the effect diminishes until it becomes invisible. Hence, in telegraphic circuits, where the area of the earth plates is very large, whether they be separately buried plates, or, as is frequently the case, a system of gas or water pipes, where the currents are but momentary, and where the resistances of the circuits are very great, the phenomena are not discernible. They are the result of electrolysis, and their energy is proportional to the affinities introduced. Their electromotive force is very slight, and never equal to that of a simple cell of the primary battery. It is only in the experiment room, or in the case of ruptured wires in the sea, that they occur to attract attention or interfere with results.

Having thus detailed the true source and nature of these currents, the inappropriateness of some of the terms hitherto applied to them is easily perceived. They are not due to any polarization of buried plates or masses of metal, but rather to the polarization of the water or moisture of the earth. Moisture is essential to their appearance, as Becquerel has also shown. Masses of metal alone are insufficient to produce any such effect. Professor Wheatstone's explanation of their cause, as detailed at the commencement of this paper, is therefore untenable. It is contrary to fact, and contrary to theory.

It is with much diffidence that I have attempted to impeach the dictum of such a luminary in our profession, and it has only been after mature consideration, and a deep conviction that the promulgation of such erroneous views, from such an authoritative source, is likely to confuse and mislead those who, like myself, are endeavouring to unfathom the deep laws that rule and guide that beautiful force that forms the basis of our profession, that I have ventured to publish this investigation. The science of electricity is making such rapid progress, that its fathers—its *patres conscripti*—require all their energies to keep pace with its

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advancement. In some particular branches, where their more youthful followers have greater access for investigation, they must expect to be outstript; and if a pupil ventures to impugn the correctness of a master's position, if his motive be genuine, he should not be censured for his temerity, but criticized for his accuracy and truth.

POROUS VESSELS FOR BATTERIES.

In the Daniell battery—by far the most important of the electromotors which have come into general use, the porous vessel, as generally manufactured, offers a considerable amount of resistance in the fluid portion of the battery circuit. In long lines of telegraph, where the resistance within the battery is always comparatively small in regard to that of the wire, the increased resistance due to the porous vessel is more than compensated by the perfect manner in which this, when carefully made, fulfils its function of separating the two exciting fluids. The case is very different when we use the battery in short circuit, or with very little resistance superadded to that of the battery itself. The resistance of the diaphragm then materially diminishes the quantity of electricity, which otherwise might traverse the circuit. For this reason, principally, arrangements much inferior in economy and convenience to that of Daniell are employed for electro-deposition, and generally for the purposes of the student and amateur. To the latter it is often a matter of surprise to find that a battery cell roughly constructed with a diaphragm of sail cloth or plaister answers its purpose far better than one on the approved model for telegraph service, or that copper and zinc in dilute acid appear more powerful as an electromotor than an arrangement in which the effects of polarization are carefully guarded against. The fault is clearly with the porous vessel, but this fault is often that the jar is far too perfect, in a telegraphist's point of view, for the purpose for which it is intended. What we principally require in telegraphy are constancy and economy; the whole available quantity of electricity that can be furnished from the battery being never actually employed, but only so much as the degree of tension enables to overcome the resistance of the line. What is generally required in a battery for other purposes is the utmost quantity of electricity the arrangement can afford. It is obvious therefore that the nature of the porous vessels used for batteries should vary according to the purpose for which they are used.

To those who have adopted the Daniell battery as the most constant, economical, and convenient, the selection of the porous vessels to be used in the same is a matter of some moment. More or less, these vessels always allow of the transudation of a portion of the fluid contained in them; and the extent to which exosmosis, as well as endosmosis occurs, may be specified as their degree of leakage. Very little observation suffices to show that the degree of conductivity in the battery vessel does not in every case correspond with its degree of leakage, or, in other words, that it may leak from excess of porosity in certain points, and yet offer a great amount of resistance from its general want of porosity. In some specimens of porous vessels manufactured by Messrs. Cliff and Co., which we have recently tested, the amount of leakage is very small, and the degree of conductivity comparatively high. These vessels are made of a compact material similar to biscuit ware, neither brittle nor friable; and for telegraphic purposes, or where efficiency for a lengthened period are required, answer admirably the purpose in view. The degree of leakage determines not only the amount of waste in local action of the zinc element, but also the period during which the vessels themselves maintain their efficiency. The causes which result in the deposition of copper, and occasionally of an oxide of the metal upon, and within the substance of the diaphragm, appear somewhat complex; but the principal one is doubtless the reduction of the metal upon the zinc element, and its subsequent precipitation, under electrical influences, upon the porous material. In the French telegraph batteries the average duration of the earthen diaphragms is six months; a period which might probably be considerably increased by the adoption of a more perfect material.

Where a current of great quantity, rather than efficiency for a lengthened period, is required, a porous vessel of plaister, offering but little resistance, will be found far preferable to the ordinary or the best descriptions of porous vessels. It is, however, desirable that porous vessels, specially intended for the Daniell battery when used for quantity purposes, should receive the attention of manufacturers. For the Grove and Bunsen battery, in which the electro-motive force is higher, and the fluid resistance less, the ordinary porous vessel answers every purpose: but these descriptions of battery arrangement would probably be very seldom employed, if a diaphragm offering but small resistance could readily be obtained for the Daniell arrangement. The amount of leakage in such a diaphragm would doubtless be considerable; but this consideration is of comparatively small importance in electrotyping or in employing the voltaic agency for the purpose of experiment and research. We may mention that very good results have been obtained, so far as the quantity of the current is concerned, by employing a vessel constructed of *felt* to contain the copper solution. However inapplicable for telegraphic purposes, this material, possessing the quality of porosity to a high degree, and not being liable to fracture, would doubtless prove of value to the experimentalist.

REPORT OF THE MEETING OF THE BRITISH AND IRISH MAGNETIC TELEGRAPH COMPANY (LIMITED).

The fifth ordinary general meeting of shareholders was held in Liverpool, on the 27th ult., Mr. W. Langton (in the absence of Mr. W. Ewart, M.P.) presiding. The report stated that, notwithstanding the existence of a new competing company for the traffic, between London, Birmingham, Liverpool, and Manchester, there was an increase in the receipts, as compared with the previous year. The increased number of messages, however, had proved wholly inadequate to compensate for the reduction in rates to one shilling messages. The directors did not believe that the public would derive any real benefit from a competition based upon an erroneous principle, and which could not be lasting. The nett balance on the year's working had amounted to £27,882, and after paying the dividend on the preference shares, and on the ordinary shares for the half-year ending June 30, there remained a balance of £13,014, out of which the directors had declared a dividend for the last half-year of 1861, at the rate of 4 per cent. per annum, leaving £2,710 to be carried over. The report and dividend were adopted, and the meeting was afterwards made special, and a resolution was adopted empowering the directors to increase the capital of the company by the amount of £275,000, by the creation of £27,500 of £10 shares, with a preference dividend not exceeding 6 per cent. The object of this measure is to enable the board to redeem the present 7 per cent. preference stock, and the bonded debt, which will absorb £235,000, leaving £40,000 to be expended on new works in the West of England, and elsewhere.

REPORT OF THE TELEGRAPH COMMITTEE.

[Continued from page 175.]

3.—*The External Protection.*

The form of the outer covering must in each case depend on the local circumstances affecting the site in which the cable is to be laid; and in selecting it, regard should be had to the fact that it is necessary to provide for the repair of the cable everywhere, except in depths which interpose a limit to the possibility of raising it.

It should be such as to protect the internal core against injuries or strains in laying or in raising for repairs, against the attacks of marine animals, and against abrasion upon a hard bottom; and it must be capable of having joints made in it with ease. It should be such as to give the cable sufficient specific gravity to ensure its sinking evenly. The material by which strength is given to the cable should be effectually protected against corrosion, and should be arranged so as to furnish the required strength with the minimum amount of elongation.

The suggestion that the materials used in the external covering should not be sufficiently good insulators to prevent the detection of injuries to the internal core during the process of covering, is one which deserves consideration.

4.—*General Conclusion as to form of Cable.*

The construction of a shallow water cable must, of course, differ from that of a deep sea cable. The shallow water cable will not be much subject to injury in laying from the strain brought upon it, but it will be liable to abrasion and injury from currents, anchors, and other causes, and must, therefore, be constructed with a view of being raised frequently for repairs. For this class of cable the preservation of the outer covering from corrosion is of the first importance. The most desirable covering would, if it could be found, be a strong metallic covering not liable to corrode in sea water, rather than iron wire covered with hemp or other material. For cables beyond the reach of anchors, and even of strong currents, it may be necessary to employ iron or steel wires to obtain the necessary strength for raising for repairs, either during laying or after they are laid. In this case the danger from abrasion is less, and the iron or steel wire must be pro-

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tected from corrosion by means of some outer covering. We think such an outer covering is to be sought in tarred yarn, protected by some cheap compound of gutta percha or india rubber. The wires by which strength is given should be laid on longitudinally, or with a very slow turn, and must be kept in place by a special binding, or by means of the covering compound. Cables of this general form may also, we believe, be made applicable to the greatest depths which will be met with. In any case the outer covering should be so devised as to prevent a strain coming on the core; and the specific gravity should be adapted to the depth and be such as to ensure the cable sinking evenly.

With our present experience we believe the safest core for a submarine cable is a strand of purest copper wire, in which solidity is obtained by one of the arrangements before-mentioned, and coated, according to the locality in which it is to be employed, with purified gutta percha or with india rubber, protected by a covering of gutta percha, and the whole served round with tarred hemp to form a bed for receiving the protecting external wires; each coating of insulating material should be tested in water of a specified temperature to ascertain that its insulation was equal to a specified standard. The size of the conductor and the thickness of the insulating material should be such as to allow of the line being always worked with moderate currents. A long cable must, however, insulate sufficiently to resist the tension arising from currents termed "deflections" or "earth currents," which Mr. Varley states have sometimes, in a distance of about 70 miles, a tension of more than 100 cells of Daniell's battery.

B.—Laying and Maintenance of Submarine Cables.

1.—*Preliminary Survey.*

Before the route, in which a submarine telegraph cable is to be laid, is decided on, a careful and detailed survey of the nature and inequalities of the bottom of the sea should be made, and that line selected where there are fewest probabilities of injuries from mechanical or chemical causes, and where (if possible) the depths are such as to allow of the cable being raised for repairs. In such a survey it is of more consequence to ascertain the relative differences of level of the bottom of the sea at every step than the actual depths; and it would be of great advantage for this purpose if some instrument could be devised which would enable the actual outline of the bottom of the sea to be traced. The actual position in which a cable is laid should be defined with the greatest precision attainable, to facilitate future repairs.

2.—*Apparatus for Laying Submarine Cables.*

The failures which have occurred in laying submarine cables are mainly attributable to the employment of ships which have not been constructed for the purpose, and of defective paying-out apparatus. This latter must depend so entirely upon the form of cable to be used, and the depths in which it is to be laid, that it must be left to the engineer to devise in each case. In depths where repairs are possible the amount of slack paid out should be sufficient to enable the cable to be raised without injury for repairs.

The question of the ships to be used is one of great importance, to which sufficient attention has never yet been paid. The ship should be of large capacity, to admit of the cable being coiled easily without injury, and great care should be taken to isolate the hold from the engine-room; it should be of a form to allow of the cable being paid out without any material alteration in the trim of the ship taking place; it should have sufficient power to enable it to maintain a speed of from four to six knots per hour in the direction in which it is proceeding, in any weather; and it should be very steady in a rough sea. These qualities point to the necessity of special ships being built for the purpose. There are difficulties in the way of this being done by contractors for laying cables, because they cannot afford to have ships idle on their hands, and they consequently either hire a ship, or build one to serve afterwards for other purposes. But we believe that a ship of the construction we have shown to be necessary for laying a cable would, when not employed in laying cables, be found extremely useful for the ordinary purposes of commerce.

3.—*Contracts for Laying Submarine Cables.*

If the contractor is made solely responsible for the safe laying of the line, he cannot be made subject to much interference by other parties: but he will put on a large additional price to cover the risk he incurs, and the extra cost to be paid does not secure the success of the enterprise. If, on the other hand, he is not made responsible, he will have little interest in the success of the undertaking, and without such interest it is difficult to secure that close supervision to the details of the manufacture which will alone obtain perfection.

The question, no doubt, to some extent, depends up on who the contractor is. But in any case we believe that a divided responsibility would be fatal to this, as it is to any other enterprise. Hence we should suggest that a defined, but limited, pecuniary responsibility should be placed on the contractor, who must therefore be allowed a certain liberty in his arrangements, but the specification for the manufacture should be drawn up by the engineer, and include clauses reserving to the engineer the right of approving of all the arrangements to be made. At present the manufacture of the core, consisting of the conducting wire with its insulating covering, is necessarily in the hands of different persons from those who contract for the manufacture of the external protection and for laying the cable; the core would, therefore, be delivered to the latter contractor in a specified electrical condition, for which he would be held liable if accepted by him.

With respect to the period for which the guarantee should be made, we believe that the best plan would be that the contractor for laying the cable should contract for its maintenance for a certain number of years, and that the arrangement should be such that whilst he received payment for the actual cost of laying, he should receive his profit, after the cable was laid, in the shape of an annual sum for maintenance, by which means the greater the number of years the cable lasted without repairs the larger would be his profit.

In providing for a telegraphic line no company can rely on the successful action of the cable; capital should be provided, not only for laying the line, but for properly constructed ships and other appliances for raising and repairing it in the depths which would admit of it, and for laying a second line to be used whilst repairs are in progress; and there should be provided out of revenue a reserve fund for the repair, maintenance, and renewal of the line.

THE FAILURE OF THE ATLANTIC CABLE.

Report of Mr. W. T. Henley.

[Continued from page 178.]

If this earth current were at all constant in its quantities or direction, it would be quite easy to compensate for it and render its effects neutral; but it is most erratic in its movements, sometimes throwing the spot of light entirely off the scale, at others changing from positive to negative and back again so rapidly and frequently, and with such regularity that it is difficult to know whether it is Newfoundland or the earth current signaling.

These earth currents in submarine and subterranean lines (like the atmospheric currents, as they are termed in overground wires) are produced by the inductive effect of natural currents of electricity moving parallel with the conducting wires, it being a well-known law of electricity that if a current moves in the vicinity of a wire or other insulated conductor, a current is set up in each wire in a contrary direction, its strength being in proportion to the parallelism of the wire with the natural current.

Any wire laid parallel with the equator, or nearly so, will have also its electrical condition disturbed by every variation in the earth's magnetism. On the first establishment of practical telegraphy, the inconvenience experienced from these currents was as annoying as it was unexpected, but in course of time contrivances were produced capable of modifying or counteracting their effects, so that but little trouble is now felt from their occurrence; although even now occasionally on some lines all communication is stopped for a short time when these terro-magnetic currents are unusually strong. On lines of 100 miles or so they only show themselves at intervals. At other times the line is quite free; but on a line of such enormous length as the Atlantic cable, electric disturbance is sure to take place on some part of it at all times; and if a current is set in motion in any part, the effect is communicated throughout the whole. In another cable (as well as in this had its insulation been more perfect) earth currents would not cause much trouble, as the working currents sent through the line would not lose their strength, as in the present case, and consequently would overpower them.

The mere resistance of the cable as regards its length would offer very little impediment to its working. The same length of insulated wire, stretched on dry earth or other non-conductor, could be worked through with a very small power and at a rapid rate. It is only when it becomes surrounded by a conductor, such as damp earth or water, or by the metallic covering of the cable, that the phenomena of induction again come into play, and the more complete the insulation the greater will be the embarrassment from induction.

The effect of this is shown when a battery is connected with the line and earth, or outside of the cable. The inner, or conducting wire, becomes charged or electrified *plus;* the outer coating *minus* (similar to a Leyden jar). When the ends are put to earth the effect goes off, but not instantly, and when the two electrified media are so far re-

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moved, as in a line of 2,000 miles, if connected with the earth, a very considerable time is occupied both in charging and discharging, causing much retardation of the current, so that I think four words per minute will be the maximum rate of transmission through any Atlantic cable with the present dot and dash system. If other plans can be worked by which a letter would be indicated by one or two signals, the rate would be increased in proportion.

As I have made use of the terms resistance and retardation, and as they are words having different meanings, I will explain what constitutes the difference. The "resistance" of a wire has the effect of keeping part of an electric current back, or diminishing its quantity, without affecting its velocity, the remainder passing as quickly as it would through a wire of the same length with less than a hundredth part of the resistance. The effect of "retardation," on the contrary, is to diminish both the quantity and velocity of the current. For example, in an overground well-insulated wire, 2,000 miles long, an electric current or impulse would traverse the entire length in one tenth of a second; through the same extent of submarine line, owing to the effect of the charge, the time occupied would be nearly a second and a half.

Respecting the question of injury to the line from the use of powerful currents—if a small hole leading to the wire exists in the gutta percha covering near either end, there is no doubt that a current of great quantity and intensity, whether produced by battery or coils, would have the effect of enlarging the breach by burning; but this can only take place to a limited extent. Heat can only be developed by an electric current when the latter meets with great resistance; consequently, as soon as that is diminished by a slight enlargement of the hole, all burning ceases. I tried the experiment alternately with the large induction coils, with the battery now here (400 cells of Daniell's) and with my large magneto-electric machine. They were each connected in turns with the line and the earth, and at the same time with a piece of gutta percha covered wire, in which the copper was bared to one thirty-second of an inch diameter, and a piece of copper in a basin of sea-water, thus dividing the current between the two routes. The coil current enlarged the fault to one-twentieth of an inch in diameter; the batteries to a sixteenth—both very slowly. That from the magneto-electric machine made no change in the fault it was applied to until it was disconnected with the line and earth, and allowed the one road only; when burning took place, as might have been expected. The fault was enlarged very slowly to one-tenth of an inch. On repetition with the coils, the fault was increased to one-tenth diameter, and with the batteries to one-sixth, rapidly with both. No further burning can take place with either current till the wire is brought to the surface of the water, when, owing to the resistance increasing, by the fault being only partly immersed, the burning commences anew and the gutta percha inflames.

On the arrival of my large magnetic machine, I put it together, and connected it with the cable, and have used it a part of every day since, sending at some times reversals and at others words and sentences. I am unable to tell whether they were received and understood, but hope to find such has been the case on the receipt of intelligence from Newfoundland. Having a machine at one end only, it will, of course, be evident that, even if they received properly, they could not have answered better than before. But we have been encouraged by seeing more reversals and attempts to send words from them lately than before. I will leave the machine here; it will be worked at stated hours each day by the assistants until the day fixed upon in October, when it will be used alternately as arranged with the battery and coils. The clerks at each end will then act according to preconcerted arrangements, which, I hope, will have the effect of renewing telegraphic correspondence. If that is not accomplished, probably the best thing then would be to raise the cable for about fifteen miles out and test. I cannot say I have any hopes of the fault being found within that distance, but as it would not be attended with any trouble or risk I think it worth the trial. If the injury is in the deep soundings, I believe any attempt to raise it would be the means of breaking the cable and losing the end altogether. If the state of the cable should not get worse I am still in hopes of its being rendered workable by transmitting signals slowly, by having delicate receiving apparatus, and by adopting means for neutralizing the earth current. Professor Thomson has partially succeeded in the latter object by throwing into the receiving end of the line feeble currents of different values, from one cell to one-twentieth of a cell, in opposition to the earth current. —I am, gentlemen, yours obediently,

W. T. Henley, *Telegraph Engineer.*

46, *John Street Road, Clerkenwell.*

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.

Fine	...	...	...	2s. to 2s. 3d. per lb.

India Rubber.

Fine Para	...	...	1s. 11d. to 2s.	per lb.
Negro	...	...	1s. 5d. to 1s. 7d.	„
Java	...	...	1s. 5d.	„

March 5, 1862. Wm. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	——
20	Do B. 7 per cent. till 1862	all	18 to 20	——
20	Do. C. „ „	all	9 to 11	——
Stock	Electric Telegraph . .	100	96 to 99	98½
20	Red Sea and India Telegraph	all	18¾ to 19¼xd	——
1	Submarine Telegraph, scrip.	all	3/8 to ½	——
1	Do. registered . . .	all	3/8 to ½	——
10	Do. „ . . .	all	4 to 6	——
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	——
10	Mediterranean Extension Tel.	all	4 to 5	——
2	Telegraph to India . .	1	¼d. to ½ pm.	——

Telegraphic News.

TELEGRAPH IN SPAIN.

In the Congress on last Friday, the Minister of Public Works promised to introduce improvements into the staff employed upon the telegraph, as well as to ameliorate the means of telegraphic communication.

THE LAW OF TELEGRAMS.

A decision of some interest on the laws of telegrams was discussed in the Lord Mayor's Court on Saturday. A gentleman delivered a message for Chatham at the office of the Electric Company, and their agents, having no wires to Chatham, handed it over to the Magnetic Company, that had. But the Magnetic Company's office was closed before the Electric, and therefore the message was not delivered. The company pleaded in their defence that, according to their printed form, they were not answerable for the transmission of messages but by their own wires, and the judge directed that the plaintiff should be nonsuited on this point, which would allow him to appeal to a superior court.

THE ATLANTIC TELEGRAPH.

The following correspondence has appeared in a morning journal:—

Sir,—At the time when very zealous efforts are being made to raise capital for the restoration of telegraphic communication with America, shown by recent events to be of such great importance, it is highly desirable that so great an object should not be hindered by erroneous statements. I therefore respectfully ask your assistance to set the public right in respect to some assertions published in one of your contemporaries under the signature of Tal. T. Shaffner, who is interested in the concession for communicating with America by way of Iceland, Greenland, and Labrador.

He states in contrast with the assumed advantages of his own project that it has been found impracticable to work in a single direct circuit the line from Malta to Alexandria recently laid for the Government, and intimates that a cable laid between the British dominions of Ireland and Newfoundland could not be worked commercially except at an original outlay upon the core of the cable amounting to nine times that required for a cable by the Arctic route.

I immediately inquired into these statements from the firms whose opinion and practice in all matters connected with deep-sea cables are conclusive, and who, as you will see, are prepared to enter into contracts to carry them out. The replies of Glass, Elliot, and Company, and of the Gutta Percha Company are annexed, and are quite opposed to the assertions of Mr. Shaffner.

Mr. Shaffner has also understated the length of the cable from Malta to Alexandria, which is 1,535 miles, instead of 1,250, and I may further state that the cost of even a moderately good line of telegraph by way of the Danish possessions to Quebec, as proposed by Mr. Shaffner, would be more than double that of the most efficient cable between Ireland and Newfoundland.—Yours truly, Geo. Saward, Secretary.

Atlantic Telegraph Company,

22, Old Broad-street, London, Feb. 27.

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"To George Saward, Esq.,
"Atlantic Telegraph Company.

"Dear Sir,—In reply to yours of this date, enclosing the letter of Mr. Shaffner, we beg to say that we believe the fact of the Malta and Alexandria cable being divided into three sections was more for convenience than any doubt as to its being capable of working well throughout its entire length.

"We can further state, without hesitation, that a suitably made and insulated telegraph conductor, laid intact between Ireland Newfoundland, can be worked efficiently, both in a commercial and scientific sense, and, we may add, that we should be prepared to guarantee the efficient and satisfactory working of a length of 2,100 miles of insulated telegraph wire, as manufactured by ourselves, and submerged and maintained in that state.—We remain, dear sir, yours very truly,

"(Signed) { The Gutta Percha Company. / HENRY FORD BARCLAY.

"*Gutta Percha Works, Wharf-road, City-road,*
"*Feb. 25th*, 1862."

"To George Saward, Esq.,
"Secretary, Atlantic Telegraph Company,
"22, Old Broad-street,

"Sir,—In reply to yours of yesterday respecting Mr. Saffner's letter in last Sunday's *Observer* we have to state as follows:—

"We did not recommend that the Malta and Alexandria cable should be laid in three sections; on the contrary, we should have much preferred to work it as a single continuous line. It was laid in sections in obedience to the directions given us by Her Majesty's Government. It was thought that a large commercial business would arise at Tripoli and Benghazi, which appears, as regards Tripoli, likely to prove the case; besides which an easy communication might, it was thought, be established from Tripoli to Algeria, if found desirable hereafter. The length of the entire line, as laid between Malta and Alexandria, is 1,535 miles.

"The whole of this line can be worked through without relay or repetition in an efficient and satisfactory manner, both as regards its scientific and commercial results, and with remarkably low battery power.

"With regard to our willingness to lay a cable not exceeding 2,200 miles in length, we would simply quote an extract from a letter which we addressed to Mr. Cyrus W. Field, on the 17th instant, in reply to a communication from that gentleman upon the subject. We therein stated: 'That we should not be willing to manufacture and lay a submarine telegraph cable across the Atlantic from Ireland to Newfoundland, assuming the entire risk, as we consider that would be too great a responsibility for any single firm; but we are so confident that these points can be connected by a good and durable cable that we are willing to contract to do the work and stake a large sum upon its successful laying and working. We shall be prepared in a few days to make you a definite offer.'—We remain, sir, your obedient servants,

(Signed) "GLASS, ELLIOT, AND CO.

"10, *Cannon-street, E.C., London, Feb.* 26, 1862."

THE TELEGRAPH TO INDIA COMPANY.

A TELEGRAM has been received from the chief engineer of this company (Mr. Latimer Clark), stating that the cable between Suez and Jubal had been successfully recovered, and that it was in a good state of preservation. An iron station (now on its way, and which was described in this journal) is to be erected on the island of Jubal, from which, as the aerial line between Alexandria and Suez is in working order, messages can be transmitted direct to Malta, *viâ* Alexandria and Malta cable. The exploring party upon the successful recovery of the Suez and Jubal section immediately proceeded to repair the section between Jubal and Corsica, which, if successful, will add considerably to the great Indian line.

THE ATLANTIC TELEGRAPH.

[FROM THE MORNING STAR.]

EUROPE AND AMERICA must not continue telegraphically disunited. The Atlantic must not be allowed to interpose an everlasting barrier to electric communication between the two worlds. The submerged and broken cables, with the half million of money expended upon it, is irrecoverable. But there remains the precious memory of messages interchanged in a few minutes between the Queen of Great Britain and the President of the United States. In such a remembrance there is more than the money's worth—the history of a glorious enterprise, the prophecy of renewed and permanent success. What was done once can be done again, and done always. Our navigators have sounded the depths profound. Our electricians have overcome the chemical action of saline floods and currents. We know now into what Alpine ridges and awful abysses and channels of the mighty deep are broken. But we know, too, that there is a vast plateau of sand and shingle spread beneath the North Atlantic, between the coasts of Ireland and Newfoundland. We know how difficult it is to deposit without break or flaw two thousand five hundred miles of cable at a depth of twelve thousand feet. But we know, too, that it *can* be accomplished—and that it is worth any expenditure. The feat has been actually performed. The cable has been safely laid. The capitals of England and America have been placed in electric communication. The speaking pipe has been stretched from London to Washington, and words of goodwill gone to and fro. In August, 1858, we learned by experiment—costly but conclusive—that marine distance is practically no greater obstacle than terrene or aërial distance to the transmission of electric currents—that signals will travel through salt water at the rate of a thousand miles a second—and that the real difficulty consists in making a cable strong enough to resist the tooth of such sea monsters as sunken rocks and sharp ridges. That this can be effected is the belief of practical men, who are willing to embark large sums in evidence of that faith. And it is proposed that the two Governments shall once more assist an enterprise in which they are so incalculably interested.

Mr. Cyrus Field, a principal promoter of the experiments made in 1857 and '58, is now in England, bearing a despatch from Mr. Seward to Mr. Adams upon this important subject. Mr. Lincoln's Government are prepared to ask Congress to guarantee two per cent. upon a capital of six or seven hundred thousand pounds, for twenty or twenty-five years, if England will do the same. The arrangement would, of course, include, as before, provisos that the cable shall be at all times, in war as well as in peace, open to both Governments for the free despatch of their messages. Two per cent. upon the capital proposed would amount only to twelve or fifteen thousand pounds for each Government—hardly a hundredth part of the extra expenditure incurred by this country alone in consequence of the tardiness of communications on the Trent affair. Could Lord Russell and Lord Lyons, Mr. Seward and Mr. Adams, have conversed through the telegraphic wires, two days would have sufficed to clear up the unhappy misunderstanding that spread itself over five or six weeks—deranging commerce, inflaming passion, and exciting all the evil spirits of both worlds to a revel of wicked anticipations and designs. Mischief must always have time to ferment. International quarrels, like alcoholic stimulants, are the results of a process, not of a momentary act. Delay, while it affords opportunity of deliberation, too often furnishes only space for the indulgence of anger and the formation of evil purpose. But, apart from the great political interests involved in the construction and maintenance of an Atlantic telegraph, the commercial intercourse of the two countries would be immensely facilitated thereby. The condition of markets, the prospects of a sugar or a cotton crop, even the state of the weather at a given moment on either coast, are subjects on which a lightning rapidity of information is invaluable. Still more sensitively affected are those greatest of all human interests which make no figure in the calculations of the politician or the merchant. England and America are the Corsican Brothers among nations—so quick their sympathies, so close their kinship; but they need the electric coil to supply the simultaneous consciousness of that mystical pair. There are thousands of families divided by nothing but that dreary space which the telegraph would reduce to the distance between the two extremes of this little island. A man might be summoned from New York, or even from Illinois, in time to attend his father's death-bed, or at least to lay him in English soil, if we had the same means of communication with America as with Italy or Algeria. What has been accomplished in the Eastern hemisphere makes us impatient of ten days' delay in sending a message to the Far West. There are no two capitals of Europe that are not within two or three hours' communication with each other. The death of the Emperor Nicholas, for example, took place at St. Petersburgh at one o'clock, and was announced in the House of Lords at five. The eastern shores of the Red Sea are now practically as near to us, for purposes of information, as the west of Ireland, and we shall presently be able to exchange question and answer with Calcutta during a single sitting of the India Council. So numerous and highly esteemed are the public and private uses of the telegraph, that the most valid objection to an Atlantic cable is the difficulty of making it carry all the messages that would be committed to it. But that is not the sort of difficulty to deter men of scientific and commercial enterprise from engaging afresh in the great work of conecting the two continents by a wire stretching from Cape Clear to Cape Race, or some corresponding promontories. The old shareholders are understood to be willing to refurnish the necessary capital. The sum required would, at any rate, not long be wanting, if a moderate interest were guaranteed by the two Governments. The most successful manufacturers of submarine cables have informed Mr. Cyrus Field of their readiness to construct a wire that only some such extreme accident as contact with a ship's anchor could damage. Mr. Gladstone is the great authority to whom we must next look for encouragement. And the strength of his repugnance to extravagant expenditure on unproductive objects, is in itself assurance that he will not obstruct by an unwise economy the completion of a work worthy of the greatest nations and helpful to the happiest times.

LONDON DISTRICT TELEGRAPH COMPANY.

THE half-yearly meeting of this company was held on Friday at their offices, 90, Cannon Street, City; Mr. Robert Taylor in the chair. In answer to a question with reference to complaints which had been made about the delay in sending messages' the chairman said that 700 messages a day passed through their hands, and there was only one complaint on the average for every 2,100 messages. The report was agreed to.

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THE TELEGRAPH TO INDIA COMPANY.

A telegram has been received from the chief engineer of this company (Mr. Latimer Clark), stating that the cable between Suez and Jubal, 200 miles in length, had been successfully recovered, and that it is now in good working order, and also that the vessel engaged on the repairs (which has been lent by the Viceroy of Egypt) was about to proceed to Kossier, a distance of some 60 miles, to pick up some heavy shore end cable, with which she would return to Jubal, and complete the establishment of a station there: (the unique iron building intended for this station, and lately described in our columns is now on its way thither). Mr. Latimer Clark had proceeded by land to Kosseir with the view of ascertaining the practicability of running a land line along the shores of the Red Sea. He will then join the *Sir James Duke*, a steamer which the Company sent round the Cape to Aden with 200 miles of cable, and will endeavour to restore the communication between Aden and Kurrachee. The faults on this portion of the line are not believed to be of a very serious character, and it is hoped that they may be repaired without much trouble. The message containing the above important and encouraging information occupied 24 hours in its transmission from the Island of Jubal to the Company's office in London.

OVERHOUSE TELEGRAPHS IN MANCHESTER.

The United Kingdom Telegraph Company, having overcome the objections of the civic authorities, have completed their overground system in Manchester by adopting the principle carried out in the metropolis, and have from five to ten wires crossing over the streets in various directions. The Universal Telegraph Company have their standards raised, but appear to have adopted single iron wires in preference to the multiple cables used in London and Glasgow. The Electric Company have a few wires overhouse from their chief offices in Ducie Buildings to the Stock Exchange. Bonelli's Telegraph Company are starting with fifteen wires from Market Street *via* Deansgate to the New River, and thence to Liverpool; and, lastly, the Magnetic Telegraph Company have an application before the Council for permission to carry sixteen wires from the Exchange to Salford.

THE LONDON AND SOUTH OF IRELAND DIRECT TELEGRAPH COMPANY.

The aërial lines of this Company are rapidly progressing. The line uniting Roche Point, Queenstown, and Cork, is already completed, and the submarine portion between Carnsore Point and St. David's Head, it is fully anticipated will be submerged in a few weeks.

SUBMARINE TELEGRAPH COMPANY.

The half-yearly meeting of this company took place on the 4th inst., at the London Tavern, Bishopsgate Street; Sir James Carmichael, Bart., in the chair.

The Chairman, in moving the adoption of the report, observed that he was sorry the accounts had not been presented to the shareholders in a more perfect form; but he assured the meeting that the accountant was in no respect to blame. Having to refer back for a considerable period of time, he could not on this occasion attain that result which was desirable. The directors, therefore, did not propose to ask the proprietors to confirm the accounts this day, but to investigate them thoroughly, and he had no doubt they would give the fullest satisfaction when they were next presented. The shareholders would see that the traffic was in a satisfactory state, the increase since the 31st of December being nearly £600, which was a clear proof that the public were gladly availing themselves of cheap and rapid communication. The Belgian Government had renewed their concession for the same length of time as had been granted by the French authorities. This would prevent the only opening on the Continent where they might fear competition, and, in point of fact, they need not have any apprehension as to opposition from France or Belgium for the next thirty years. The honourable gentleman then referred to the proposed agreement with the Magnetic Telegraph Company, and said that as Mr. Saunderson, one of the directors, had issued a circular in opposition to that agreement, he (the Chairman) thought it right to say that the Magnetic Telegraph Company were shareholders in this company to the extent of £22,000. Furthermore, their shareholders had subscribed some £30,000 to this undertaking, and there were, besides, independent shareholders in both companies holding stock in the Submarine Company to the amount of £40,000 more. The Chairman concluded by moving that the report be received and adopted, and that the consideration of the accounts be adjourned until after the completion of the investigation now being made into the financial position of the company.

Literary Notice.

AN ILLUSTRATED HAND-BOOK TO THE ELECTRIC TELEGRAPH. By Robert Dodwell. London: T. T. Lemare, Paternoster Row.

A popular and amusing account of the electric telegraph, divesting the latter of the mysterious character it still holds amongst the great majority of the public, is a requirement of the day, which is well answered by Mr. Dodwell's publication. Mr. Dodwell is well known in several of the northern counties for his amusing and instructive lectures upon the electric telegraph; the substance of which, in great measure, we have here reproduced. It is well entitled in the preface *A Sketch of one of the greatest Wonders of the Age;* and there is doubt that it will lead many to further enquiry and study relative to an application of science which is yet capable of great extension. The publication will be of peculiar interest to many of those who are practically engaged in electro-telegraphy, and who have not yet studied the organization of the telegraph.

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

TUNNEL TELEGRAPHS.

To the Editor of The Electrician.

Sir,—Can you or any of your correspondents inform me what kind of telegraphic instruments were used for signalling the trains through the tunnel on the Brighton line when that lamentable accident occurred a few months ago. I remember looking anxiously through the reports of the inquiry then instituted, but failed to discover anything relative to the kind of instruments employed, and whether they had the common electric alarum attached.

I am not an advocate of the alarum bell as used at many tunnels; but on the contrary, I think it a most unreliable and dangerous instrument; and at some future day I intend to write to you more fully upon the subject, and endeavour to point out a very simple instrument, which I consider (and hope to prove) well adapted for signalling trains through tunnels.—I am, your obedient servant, Inquisitive.

Manchester, 1st March, 1862.

METEOROLOGICAL CHANGES, &c.

To the Editor of The Electrician.

Sir,—Your appeals to your readers from time to time for assistance in carrying out a system of meteorological observations with regard especially to magnetic storms and earth currents has found its way into the council of the British Meteorological Society. I have now before me several of the yearly reports of the above Society, containing no reference whatever to the important question to which you have called attention. In the first number of their proceedings, lately published, the subject of magnetic storms and earth currents is the most prominent of all other matters, and we are promised a series of papers upon these phenomena.—Yours, &c.,

Meteorologist.

ATLANTIC TELEGRAPH.

To the Editor of The Electrician.

Sir,—As week by week passes we are provided with something new in connection with the above national project, and we are specially directed to the arrival of Mr. Cyrus Field. If the particulars of his mission, could be made known to the public at large, the proposals could be considered by the commercial community, and if satisfactory, would meet with the necessary means to carry out this very important undertaking.

The reply of Mr. Milner Gibson to Sir William Galloway respecting the intentions of the English Government in the matter, clearly indicates that there are many difficulties to be encountered, as we cannot forget the many causes connected with the last failure, and which must, from the recent valuable experiments, and under good management, be avoided in future. It is highly amusing, although perhaps very imprudent, for any of our daily papers to devote leaders and paragraphs in their columns, in such form as to cause the opinion to be generally given that this or that must be really the last or most improved method of advertising one particular material, or the special interests of any particular firm or company. Sir, is it not virtually important at the present moment to call together and publicly exhibit every description of scientific and mechanical arrangement, to show everything that has been invented for the purpose of improving the telegraphic system generally; and in connection with it I would suggest the propriety of forming a committee of scientific men, wholly unconnected with the profession of telegraph engineers, and that they should be empowered to award prizes in accordance with the various designs submitted to them. As most of us are aware, the object is permanently to establish telegraphic communication between England and America, and it cannot at present be wise to entrust the work to any firm who may have even been largely engaged in manufacturing cables for shallow water, as they may not be at all likely to succeed in crossing the Atlantic Ocean.

There are other things to be considered, viz., the difficulty of insuring the cable when made, and this is perhaps a good feature, as really any contractor might be relying upon a large margin of profit. To insure the cable at a very high rate, so that it would not affect him, in a monetary sense, if the cable ever succeeded or not, would be quite immaterial.

So that as a large sum is required for a great national undertaking, let caution be the watchword of all those who feel deeply interested in the project.—I am, sir, yours most obediently, Truth.

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BITUMEN.

To the Editor of The Electrician.

Sir,—Will you kindly inform me in your next paper whether bitumen be a good or a bad conductor of electricity, and if it be a non-conductor can you inform me where I can get a small quantity, as I wish to try a few experiments.—I am, your obedient servant, Inquisitive.

[Bitumen is a very good insulator, but owing to its brittle character is somewhat difficult of application. We believe that it is readily to be had at the drysalters.—Ed. E.]

To the Editor of The Electrician.

Sir,—In your article, "Student," you make reference to the form of battery as suggested by me, your remarks on the various methods of attaching the electrodes, by depositing copper on the carbon, is certainly a very good plan. I forgot to mention the plan I adopt when using iron for the positive plates of 3 or 4 couples. I carry a strip of iron from the positive plate about half an inch wide, this piece I heat to redness, which will render it inactive or passive to the nitric acid which is absorbed by the carbon, and rises to the top of the electrode. The largest piece of coke to which the electrodes are attached is soaked well in black lead and water, and, when dry, polished with a brush, which will give a good metallic connection with the iron, or any other metal used as an electrode. There is a paragraph on the use of peroxide of lead for the exciting agent; is it used for the positive or negative agent? If for the negative, is there any advantage over nitric acid? There is an article on the renewal of "Porous Jars." I can say that using iron as a positive metal, the inconvenience alluded to never occurs; I can only say I use my iron battery for hours together, and it seems to be in quite as good action as when first commencing. Is it in consequence of the nitric acid working slowly through the porous tube? Your columns are silent on the use of iron for the positive element. Am I in error in supposing I obtain the same amount of electricity from iron (using the acid solution stronger) as I should from zinc, the same weight of metal being dissolved in the same time? The amount of iron dissolved appears to me very small for the effects produced; the current is certainly more constant, and the action of the battery seems to go on very regularly. A few words from you on this subject will be deemed a favour, as the price of zinc, compared with that of iron, is certainly very great, if the same effects are produced.—Yours truly, J. Cook.

[The peroxide of lead is used for the negative element; its advantage over nitric acid is that it is neither corrosive nor capable of giving off acid vapours. The porous vessels which become clogged are those used for the Daniell battery. We have failed to obtain the same results with an iron positive as those you mention—perhaps by reason of the quality of the iron employed. We fully recognize, however, the importance of substituting iron for zinc, should this be practicable; and it is very desirable that careful experiments should be made on this point.—Ed. E.]

To the Editor of The Electrician.

Sir,—It is gratifying to see that the projected telegraph across the Atlantic is not likely to be allowed to evaporate in mere smoke. From an article which appeared in the *Daily Telegraph* of Saturday last, the thing seems to be assuming a degree of tangiblity; and a disposition seems to be evinced by the American Government, as well as our own, to forward an enterprise so conducive to the peace and prosperity of both countries, and what could possibly be better than to bury in the depths of the sea, along with a thoroughly good cable, the recent ill feeling which has been momentarily exhibited.

But it is not so much to notice what all thinking men look upon as a certainty which requires only a little time to work the accomplishment of, that I allude to this subject, as to call the attention of your readers to the extraordinary statements therein made, extraordinary to me, at least, who am, of course, but a mere outsider. The writer in the *Daily Telegraph*, by stating the names only of two firms in the field as contractors for the construction of the cable (which two firms in reality are but one, bearing distinct names and with distinct and separate establishments, one supplying the raw material, and the other constructing therefrom the core, and sheathing the same with iron wire afterwards), would convey the notion that the parties in question were really the only firms that could undertake and accomplish such a contract; nay, more, you might conclude from that article, that the firm in question were the only constructors of submarine cables in existence, and yet I see in the Electrician and other journals, which sometimes come under my notice, the advertisements of at least half-a-dozen different firms who are prepared to tender for the contract of submarine cables, not excepting one across the Atlantic.

To the best of my recollection the firm so prominently set forth in the article above referred to, did the lion's share of the construction of the old Atlantic cable, which so miserably perished before it had learned to lisp. After so rich a bit of experience I should pity the shareholders of a New Atlantic Cable (if the thing be undertaken by a company) who would again invest their capital in a gutta percha covered wire sheathed with iron. And if undertaken by the respective Governments of England and the Northern States of America, I should consider both Governments justly censurable in risking a sum of money (which would form a considerable item in the half-year's budget) on a cable constructed in a manner, and of such materials, that in so long a length would prove a certain failure even as it did before, and then the overtaxed people on both sides must pay the piper.

There are other points in the article of the *Daily Telegraph* which might be animadverted upon, betraying a mere hearsay acquaintance of the matters upon which the writer descants; but, doubtless, some of your numerous correspondents, with more leisure, will have something to say upon the subject, and as they are unquestionably better acquainted with such things, they will be able to handle the subject with more ability than An Outsider.

Miscellanea.

An amusing incident occurred in a telegraph office not long ago. A lady had sent a message to a friend, and had been surprised to see it passed up a shoot, which led to the Signals' Room, at the top of the building. After waiting some time the answer came down by the same means, and was handed to her in an envelope, duly fastened. She looked wonderingly at it. "Has this come from London?" she asked. "Yes, ma'am," replied the clerk. She paused, and then looking steadily at him, said, "Why, young man, the wafer's wet!" He explained that for the sake of secresy, all messages were enclosed in envelopes before being sent out; but even then she doubted him, and as she left the office he heard her say to her companion, "I'm quite sure this is not Louisa's handwriting!"—*Dodwell's Hand-Book to the Electric Telegraph.*

On Telluric Currents.—M. Fremont considers that the currents are due, "partly to the agency of *chemical causes*, partly to *thermal causes*, partly to the terrestrial electricity." He believes, "that lines above 1,000 feet in length, if not under ground, are of no use for the investigation of terrestrial electricity, because, under all atmospheric circumstances, the disturbance produced by thermo-electric currents will be too great." He thinks that, "the first thing to be done now is to find the means of separating the effects of terrestrial electricity from other causes; and then the nature of the electric currents, and their dependence on local and atmospheric circumstances must be ascertained." By an arrangement of wires, which he describes, he adds, "It would be possible, by simultaneous observations, to decide all the important questions relating to the parallel motion of electric waves, their coincidence with the magnetic variations, the influence of change or resistance in the soil, the influence of temperature, humidity, &c."—August 24th, 1861. He finds by observation, "that different parallel lines manifest identical currents. From this it must be concluded that *there exists an electric current which is propagated parallelly on the surface of the earth, whatever be the nature of the soil.*" He notes that an E.W. current corresponds with an augmentation in magnetic intensity, and "when the galvanometer indicates a current from the north to the south, the western declination undergoes an increase." The proposition to which he arrives is, that "*magnetic variations, which are manifested at short intervals, are produced by the terrestrial current.*" On account of the continued changes of temperature humidity, both in the metal earth-plates and in the conducting wires, he has placed the latter under ground, and beyond the immediate influence of heat.

To Correspondents.

L. L. S.—The only instrument which gives a true indication of the quantity of electricity furnished by the battery is a galvanometer with a few turns of stout copper wire, or of a copper strip, the resistance of which to the passage of the electricity is so inconsiderable that for practical purposes it may be neglected. On such an instrument one cell of a battery gives the same amount of deflection as 1000 cells associated for tension. The ordinary galvanometers, even those which are termed *quantity* galvanometers, offer considerable resistance to the passage of a current of low tension. This is proved by the increased deflection obtained by connecting several couples for tension. They are also too delicate for measuring batteries against each other; a square inch of zinc and copper in acidulated water will sometimes deflect the needle almost to its limiting stops. The quantity galvanometer, with one or two resistance coils of 1000 yards of copper wire, is very useful for measuring approximatively both the quantity and the tension of battery currents. *E.g.*, with galvanometer in short circuit we will suppose a deflection of 30° to be obtained. Place one of the resistance coils in the circuit. If the deflection be now very weak, the tension of the electricity is shown to be insufficient to enable more than a small quantity to traverse a circuit of the resistance represented by the coil. If the deflection be but little diminished, the tension of the electricity is shown to be sufficient to overcome such resistance. *Tension becomes useless where there is no resistance to overcome, and quantity without tension is useless where there is considerable resistance in the circuit.*

Uniquity.—It is a private enterprise, and owes solely its origin and success to the indefatigability of Mr. Reuter, who employs agents in all parts to transmit to his London establishment the earliest news. Mr. Reuter has several establishments in the metropolis united together by telegraph. Sensation telegrams are exceptions, not the rule.

Several communications are deferred until next week.

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The Electrician.

Vol. I. No. 19.—March 14, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 207.]

88. The celebrated Coulomb, in the early days of the French theory of electricity, made a number of exact experiments by charging a series of conducting spheres of different sizes placed side by side, with a view to discover a ratio between their surfaces and their capacities for charge; and the practical results he thus obtained were afterwards compared with laborious calculations mathematically deduced by the no less renowned geometrician Poisson. Both those philosophers conceived the cause of the capacities of bodies for electrical charge to be *within the bodies themselves*, and both failed in the object they were seeking after, so far at least as concerned the discovery of any law of charging capacity calculated to be of the least use to electricians; our theory imputes their failure to an erroneous conception of causation, and justifies that conclusion by conferring on bodies, through circumstances external to their surfaces, just those charging capacities that are found in nature.

89. We may remark, too, that in our own days an electrician, making researches with the same object, planned and executed an extensive series of experiments, of which it is not too much to say that whether we regard them as specimens of scientific device and manipulation, or for the importance of their indications, it would be hardly possible to lavish upon them too much praise; but, and that *but* has been a drag upon electricity for a quarter of a century, that expert experimentalist has persisted in looking, like Coulomb before him, within the conducting surfaces for the cause of their capacities, so that his practical successes, coupled with his opinions, have left electrical theory as dark, or darker, than they found it.

90. But now that we comprehend the conditions upon which a charged conductor can set up an artificial equilibrium by aid of the aërial matter surrounding it, we shall have no difficulty in theoretically deducing the relative capacities for charge, either of detached insulated conductors varied in size and form, or of different parts of a large conductor of irregular figure. This is what we are proposing for our next task, and in order that what we shall have to say may be perfectly intelligible let us here explain what we understand by the expression *charging capacity;* we hold the relative charging capacities of different portions of common matter, whether they be in conducting communication with one another, or separated by insulators, in short, however they may be situated, to be expressive of the relative quantities of electricity they can at the time either receive, or lose, under any given intensity of electrical action.

91. And as we have already demonstrated (80 *et seq.*), that charged surfaces freely surrounded by the air, have, under equal intensities of electrical induction, inductive atmospheres that extend to equal distances; it follows that under any given intensity of action they will have relative charging capacities that vary in a simple ratio with the surfaces of their enveloping atmospheres, all measured at one particular distance. It was thus that we proved that the little middle ball in figures 7 and 8 had a considerable charging capacity in one of the cases there shown and none in the other; and also that in fig. 6 the capacity of the larger sphere, *b*, was more considerable than that of its smaller associate, *a*.

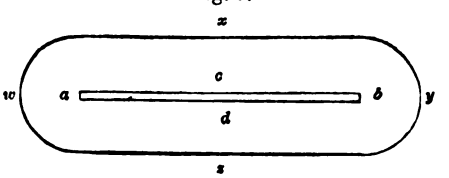
92. Nothing is more common to us than to read in works on electricity that different parts of one and the same insulated conductor of irregular figure freely insulated in the atmosphere have different electrical intensities; and there are facts that will readily occur to the mind of every experienced electrician to dispose him, looking at them in the light to which he has been accustomed, to acquiesce in that conclusion. But it is, nevertheless, a mistake, as we shall presently make evident by assigning the appearances to their proper causes; at present it will suffice that we have recorded this caution, which we can accompany by an assurance that the facts which may seem to warrant a conclusion adverse to our theory in this respect, will range themselves on its side, affording it demonstrations of the very highest importance, and even indicating to all who shall have mastered its principles, the direction of a passing charge or current of electricity, dynamic as well as static, and that in a manner which in all reason should be deemed conclusive.

93. These particulars can be conveniently discussed only in their proper places; but even now there is one remark concerning them, suggested by strict mechanical principles, that ought to be made; let the cause of the distribution of plus electricity on the surface of a conductor be what it may, it is quite impossible to believe that the distributing force at any of its parts can be in action without being opposed by an exactly equal amount of reaction of some kind at that particular place; now all such reactionary forces must be equal to one another in intensity, for if they were for an instant unequal, the action would accumulate at the points of feebler resistance until it became great enough to establish equality. This, which is so well known to be true with respect to physical forces generally, cannot be objected to in the case of the electrical force in particular, because electricity on the surface of a conductor is practically known to have free access to every part of it. Therefore, the intensities of the reactionary force being at all places equal in the case of a conductor charged with electricity, so also must be the intensities of the electrical action at all the places, since the actions and reactions are everywhere equal to one another.

94. On the principles of causation to which we are referring the charging capacities of bodies freely surrounded by the air, they would, relatively to one another, admit of a very exact determination by the processes known to mathematicians, however much the bodies may differ from one another in figure or in dimensions; but such minuteness here is not necessary, and would be unfit for a popular treatise like ours; it will better suit our readers if we lead them to use their theoretical knowledge by examining more generally, and by the aid of diagrams, the principles upon which the charging capacities are conferred; for the results thus to be obtained will so perfectly coincide with those of experiment as to satisfy them that they are dealing with something more than an artificial cause for the phenomena under observation.

95. Let the following (Fig. 9.) represent in section a charged

Fig. 9.



conducting disc or flat plate, with its inductive atmosphere, supposed, collectively, to be cut through the middle; the circumference *w x y z* being taken as the measure of the charging capacity of *a c b d*, the diagram will show that the charge will be

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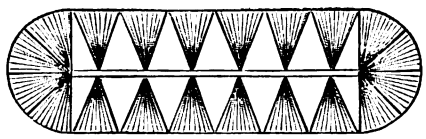
unequally distributed, much of it resting on the ends *a* and *b*, which represent parts of the periphery of the plate, and but little of it on *c* and *d*, that is about the centres of its two flat surfaces. The following Fig. 10 further illustrates this by adding in outline equal pyramids (68) that may be imagined to surround a point, and which express the progressive diffusion outward of the inductive action.

Fig. 10.



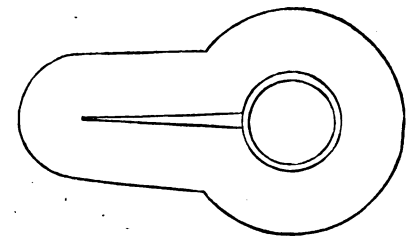
96. To examine practically this theoretical deduction make the following arrangements :—Keep the ends of two canes of glass in a clear fire until they have attained a fusing heat, then withdraw them, and after causing them to adhere together, draw them asunder so as to obtain a slender needle of glass six or eight inches in length. With a little sealing-wax cement one of its extremities perpendicularly to the centre of the back of a small disc cut out of gold or silver paper, which will thus be made a minute insulated conductor, usually called *a proof plane*.

Exp. 18. Remove from the gold-leaf electrometer its ball and wire, and screw in their place upon its summit the inverted brass cup (84). Place upon the insulated table (54) a disc of metal six inches or more in diameter, with rounded edges; and give it an electrical charge by a temporary communication with the positive conductor of the revolving machine. Holding the proof plane by its insulating handle, lay its flat surface for an instant upon the charged disc near to its periphery; it will in that position, as we can readily understand, assume the charging capacity and absorb the charge of the portion of surface it temporarily represents; transfer that charge to the gold-leaf electrometer by introducing the proof plane to the bottom of the inverted cup on its summit, and note to what extent the leaves become thereby deflected from the perpendicular. Quickly discharge the electricity from the leaves and the proof plane, and bring the latter a second time into contact with the charged disc by laying it upon the centre of its upper surface; on transferring it to a contact with the electrometer as before, the leaves will diverge to a less distance than on the former occasion, showing that the centre of the disc contains a lesser quantity of electricity than the parts near its periphery. We say a lesser quantity; others before us have said a lesser intensity, but with what reason will hereafter appear. That the *intensity of the electrometer* should be greater in one case than in the other, is perfectly well accounted for by the transfer to it by the proof plane of unequal quantities of electricity; for the proof plane will have taken away from the disc in each case the quantity of electricity forming the charge of the spot upon which it was placed, and, by the theory, the charges of the two spots ought to be unequal. It is therefore reasonable to say, that the difference in the intensities of the electrometer proved that a difference existed in the quantities of electricity on the two parts of the disc, in consistency with the doctrinal assertions.

97. During the time that charging capacities have been referred to some unknown condition within the conductors themselves, it has not been a settled question whether the indications of the proof plane are to be relied upon as denoting the exact electrical charges of the spots upon which we successively place it; this difficulty now gets its solution from the theory, because, under the circumstances in which it is used, the proof plane deprives the spot upon which it rests of all inductive atmosphere, monopolizing to itself whatever portion of it that spot would have had if the proof plane had been absent.

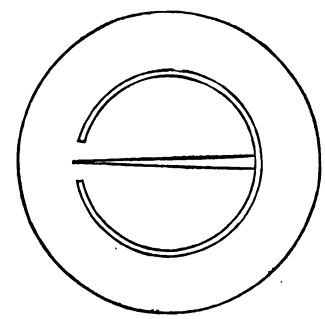
98. Having thus shown why the charge of a flat plate collects together about its periphery, and also how the electrical charges of equal areas at different places on its surface, when transferred in succession to another conductor insulated in the air, exhibit unequal intensities, we may pass on to apply the same principles to insulated conductors of more irregular figures; and we shall select for the purpose a few whose diversity of configuration is greatest, concluding that if the theory be found to apply satisfactorily to them, it will be taken for granted that it is applicable to all others less dissimilar.

Fig. 11.



99. The above diagram represents in section a charged hollow ball, with a long projecting wire sharply pointed, both surrounded by an inductive atmosphere. We can easily understand why a point in such a connection shall possess the lion's share of the plus electricity, so often miscalled the greatest intensity; so that it would be a work of supererogation to put the pyramids into the figure to illustrate the case any further. And in practice the corresponding fact is so commonly known that we need only thus cursorily allude to it, especially as it will have again to come under our notice, when we shall have to speak particularly of the cause of the point's greater apparent intensity.

Fig. 12.



100. This figure shows in section a charged hollow ball, with a large hole in one part by which its inner surface, as well as its outer one, is exposed to the atmosphere, and with also a pointed wire in its axis, reaching from it as far as the centre of the hole, but not projecting beyond it. In this position of the point the theory confers on the whole conductor no greater charging capacity than it would do if it were a solid, for the point can only act as an elementary part of the external surface in obtaining an inductive atmosphere, while the rest of the wire and the whole of the inner surface have almost no inductive atmosphere at all—certainly none but for intensities so low that they may well be conceived to be inappreciable. If the student choose to make the experiment of comparing such an apparatus with a plain ball of exactly the same diameter, he will find they will receive equal charges under equal intensities.

101. We have before experimentally shown (54) that an insulated ball, wholly within a hollow conductor, may be made to touch it without acquiring an electrical charge; we could not then stop to explain the reason, as we had not prepared the way for it, but now the student will hardly need that it be explained. And he will understand too, why, in using the proof plane, we directed him to plunge it to the bottom of the vase on the summit of the electrometer (95); for it is evident that while so placed, the proof plane, deprived of its inductive atmosphere, must give up its electrical charge to the external conducting surfaces in communication that have such an atmosphere. Let

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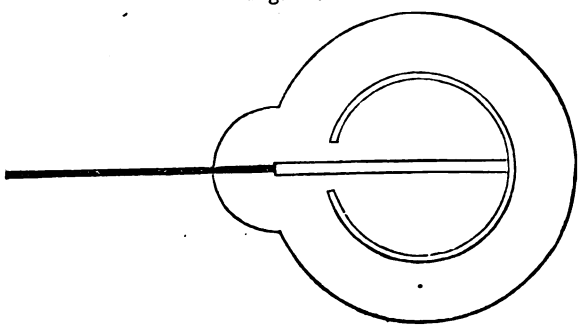
him now modify the case; instead of placing a conductor *wholly* within a charged hollow vessel, let him introduce through the centre of the hole of a hollow ball an insulated wire long enough for one of its ends to protrude externally beyond it, while the other end of the wire rests against the inner surface, as figured in section by the following diagram:—

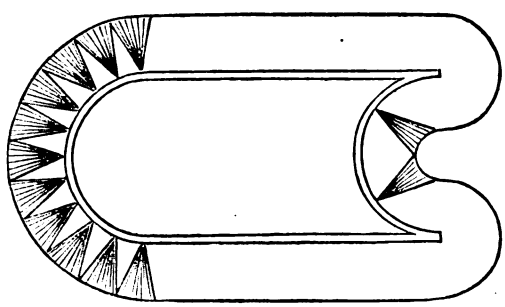
Fig. 13.



We perceive, theoretically, by an inspection of the outline traced at equal distances from all the conducting parts in this figure, that part of the wire has an inductive atmosphere and consequently an electrical charging capacity; and that this is true, in fact, may be readily proved by transferring such a wire as we have figured from its position to the gold-leaf electrometor, for its leaves will thus be made sensibly to diverge.

102. One other case must suffice; we give in Fig. 14 a

Fig. 14.



representation of a charged cylinder closed at one end by a concave surface, and at the other end by a convex surface; the figure is supposed to be, like the former ones, in section, and has its inductive atmosphere traced around it in outline. We have placed both upon the convexity and the concavity the vertices of pyramids which have been suggested by the theory; and these show at a glance that the charging capacity of the convex surface must be greater than that of the concave surface, which the student will find to be a fact if he make trial with the electrometer and the proof plane, taking the precaution not to place the latter on any part of the concave surface in the vicinity of its prominent border.

103. We could greatly extend these illustrations, but we may safely leave both the experienced electrician and the comparative novice to do it for themselves; the former will frequently recur to facts with which his memory will be plentifully stored, finding for them as they successively present themselves satisfactory theoretical solutions, while the student, if he understand what we have been attempting to teach him, will be able to devise forms of experiment which to him at least may be new, and all the more impressive from that circumstance.

104. The causation which we have thus by a few paragraphs and figures described, comprehends but a small section of the subject of static electrical induction, even so far as it is concerned in establishing the artificial electrical equilibrium; and beyond that subject in all its entirety, it will be found to extend itself further than we can yet venture to intimate.

(To be continued.)

ELECTROLYSIS.

Electro-plating with silver and electro-gilding are as yet the only commercial applications of electrolysis. It would be strange if the control we obtain over the chemical affinities of bodies by means of the voltaic battery should result in no further additions to the economic processes of industrial art. Chemistry is but one-handed when unaided by electrical science. How is it then that chemistry finds an application in every art and every manufacturing process, and that her twin sister, so wonderfully active in the laboratory, is so behind hand in this age of practical adaptation? It may be, to some extent, because coal and caloric are cheap, zinc and electro-motive force more costly. So far as our prime motors are concerned, the reason is valid; in other respects it is more than questionable. The consumption of a grain of zinc, as Mr. Joule has shewn, is much more costly than that of a grain of coal, and produces not more than one-eighth of the *mechanical* effect of the latter. But the consumption of one grain of zinc in the battery may produce far greater *chemical* effect than the combustion of many hundred grains of fuel. The zinc consumed in the battery may again be obtained as a metal by a small expenditure of fuel.* A cheap battery is certainly a desideratum, but what we most require is the practical application of electrical science, in new directions, by men who have knowledge and energy sufficient for this purpose. It is true that such men could scarcely look forward to the prospect of immediate self-advancement—so rare to the initiators and innovators of every time; but there is ample honour to be won by the Curtius who would fill up this scientific void.

It may be not uninstructive to contrast the mode of operation, in regard to one or two problems of chemical science, of our two great workers in Nature's *areana*—the Chemist and the Electrician. Let us take a very common substance—common salt—and bid them extract from it the hidden metal sodium, which may be useful to us in some other operation. We will allow to the chemist the use of the powerful reagent sulphuric acid, common limestone, and carbon for deoxidation and for fuel. To the other we will allow three or four battery couples, and that he may obtain the sodium in combination with mercury as an amalgam. The chemist prepares his furnaces, converts the chloride into a sulphate by the aid of sulphuric acid and heat, mixes the latter salt with limestone and carbon, and again by heat changes the sulphate into the carbonate of soda. The carbonate of soda intimately mixed with a fresh portion of carbon, and submitted to distillation in an iron retort, at an intense heat, furnishes the metal sodium. In this instance, at least, we see that caloric is the principal agency employed by the chemist, and we are enabled to appreciate the advantage to him of cheap fuel. The electrical operator employs what has been termed "caloric in a polarized form"—a far more subtle and powerful agency than heat. He places the common salt, dissolved in water, in a shallow vessel, in which stands a porous jar containing a portion of mercury. The positive wire from his battery he brings into contact with the solution; with the negative wire he touches the fluid metal. Immediately the mysterious agency begins its work, the mercury trembles and vibrates, increasing in weight and volume by combination with the metal we are seeking. The porous vessel is now covered, to exclude as far as possible atmospheric air; and the whole arrangement is placed near an open fire, or in the sunshine, that the warmth may promote the electrical action and the evaporation of the fluid portion of the electrolyte. In a short time, the separation of the sodium from the negative constituent of the salt will be complete; and the amalgam of sodium—from which, if necessary, this metal may be obtained separate by a process of distillation—may be covered with petroleum, and placed amongst other products of the laboratory.

Perhaps the most important practical use of sodium is in the production of the beautiful metal aluminium, which forms the

* See page 85.

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greater portion of the clay beneath our feet. It has been supposed that aluminium would form an excellent conductor for telegraphic purposes; but it has recently been shown, that in conducting power for electricity, this metal is greatly inferior to copper. In other respects, however, the properties of aluminium and of some of its alloys are extremely valuable. The following account of an alloy containing ten per cent. of aluminium and ninety per cent. of copper is taken from our excellent contemporary, the *Mechanic's Magazine*:—

"It is a perfect chemical combination, and has no tendency, as is the case with ordinary alloys, to separate under the influence of heat. These proportions represent an exact number of chemical equivalents of the two metals. Aluminium bronzes are of a yellow or orange colour, closely resembling gold, and take a fine polish, equal to that of steel. The chemical properties are the same as those of other copper alloys. In tenacity they fully equal steel. Drawn into wire No. 16 guage, the breaking strain of copper, according to Mr. Gordon, was 190, of iron 280, of aluminium bronze 434; showing a strain of 84 kilogrammes to the square millimètre. Good French iron, in Deville's experiments, broke at a strain of 60 kilogrammes the square millimètre, and steel wire at a strain of from 90 to 100 kilogrammes. It thus appears that steel, and that of a fine quality, only can stand a comparison with aluminium bronze in respect of tenacity. As regards hardness, a comparison was made between a steel and a bronze groove for the guide box of a locomotive engine, and, after six months use, no trace of wear was perceptible; the bronze gave a result equally good with the steel. It was also tried for the journals of the front wheel of a locomotive, with excellent results—its great malleability, combined with hardness and tenacity, rendering it well adapted for this purpose, where ordinarily a very brittle alloy is used. The bronze containing 10 per cent. of aluminium can be rolled at all temperatures, from cold up to a bright cherry red. It rolls well at a bright red heat, breaks less and elongates more than pure red copper. It is difficult to roll cold, and, after a number of passes through the rolls, it elongates no further; it is then necessary frequently to reheat it, as it hardens rapidly under the rolls. It is desirable to roll it at as high a temperature as possible, short of fusion. Reheating and plunging in water to cool, renders the alloy more tractable than simply reheating without dipping. If reheated to a bright red heat, and not dipped in water until it has been left to cool in the air down to a low red heat, it is sufficiently malleable and ductile, when cold, to bear, without breaking, the ordinary manipulations in working it, except some descriptions of stamping."

The electro-deposition upon copper of a small portion of aluminium was effected by Goze by means of a single voltaic couple. With a somewhat higher tension, the electrical operator may readily form the valuable alloy referred to. Instead of first obtaining sodium, and by its means reducing the chloride of the metal aluminium, which would be the process adopted by the chemist, he may effect the electrolysis of a solution of this salt and at once obtain the aluminium as a deposit upon copper. Thus, with a positive electrode of platinum, and a negative electrode of thin sheet copper, we have been enabled to obtain a sufficient deposit of aluminium from the chloride solution to form a perfect alloy, when the copper is subsequently fused out of contact with air.

Much might be said upon the almost instantaneous production by electrical agency of compounds which can only be obtained, according to the ordinary methods, by complicated chemical reactions. The above observations are, perhaps, sufficient to show the diversity of the means which may be employed for effecting the same chemical result. In many instances, we think the voltaic battery might be employed with advantage in lieu of the furnace, in the processes of metallurgy and operative chemistry; and the time may not be far distant when it will receive such application.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

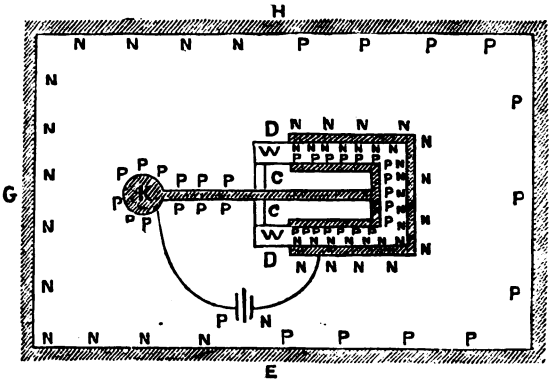
BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 209.]

If the inductive action goes on practically entirely between the exterior surface of one insulated conductor, and the interior surface of another, then no great increase of the total accumulation can occur by connecting the exterior one to the surrounding conducting surface.

Thus let fig. 41 represent a Leyden jar (seen in section*), the inside coating, C, of which is connected to the positive side of a source, the negative side of which is connected to the outer coating, D, of the jar.

Fig. 41.



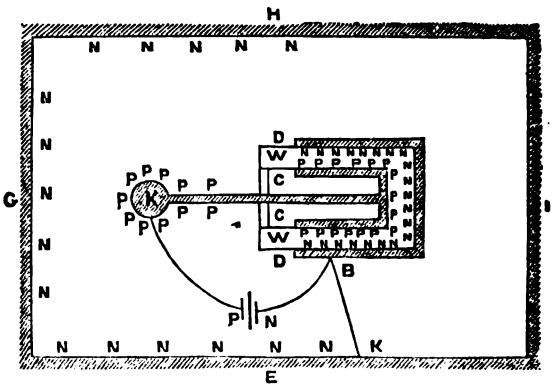
Two inductive circuits will exist, the one direct from the P side of the source to the inner coating, and thence across the glass, W, to the outer coating, and back to the N side of the source; the other indirect from P to the knob and rod K, and thence across the air to the surrounding surface E G H I, and from thence again across the air to the outside of the outer coating and thence to the N side of the source.

The outer surface of the inner coating, and the protruding brass wire and knob, will be positive; and the inner and outer surfaces of the exterior coating negative, whilst the surface E G H will be negative, and E I H positive.

The density on the knob will be greater than on the outside of the exterior coating, as we have equal quantities on a much smaller surface on the former than on the latter.

If now we connect the outer coating to the surrounding conducting surface by a connection B K (fig. 42), we shall not alter

Fig. 42.



the accumulation on the inner coating, and on the inside of the outer coating, on which surfaces the principal accumulation occurs, for we have not altered the resistance of the direct inductive circuit in which these surfaces are situated.

With regard to the indirect circuit, by forming the connection B K, we shall neutralise the charge on the outside of the outer coating by recombination with its equal and opposite induced charge on the surrounding conducting surface, H I E, and as we thus also reduce the resistance of the indirect circuit (which now becomes a direct circuit), in which the knob is situated, the quantity on the knob, and its opposing quantity on E G H will be increased. The outer coating now forms part of the surrounding conductor, and as all the inductive paths (though of very different lengths), cross only one stratum of dielectric, and all take the same direction, there may be said to be but one

* Proportion in the different parts is not adhered to, in order to make room for the lettering.

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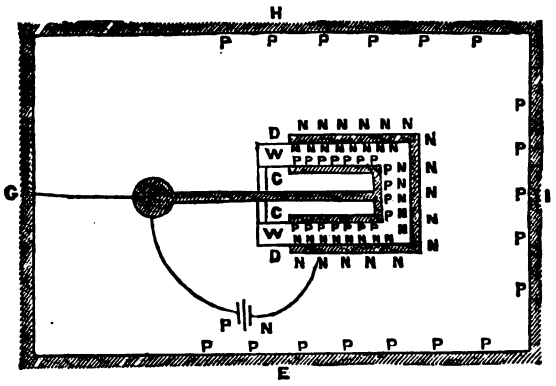
inductive circuit, and the distribution that would take place is shown in fig. 42.

If now, instead of the outer coating we connect the inner coating to the surrounding conducting surface, as in fig. 43, two

Fig. 43.



branch circuits may be said to be formed, though both pass through only one stratum of dielectric. The one passing from P side of the source to the interior coating, and from thence across the glass to the inside of the exterior coating, and thence to N side of the source. The other from the P side to the surrounding conducting surface, and thence across the air to the outer surface part of the exterior coating, and thence to the N side of the source.

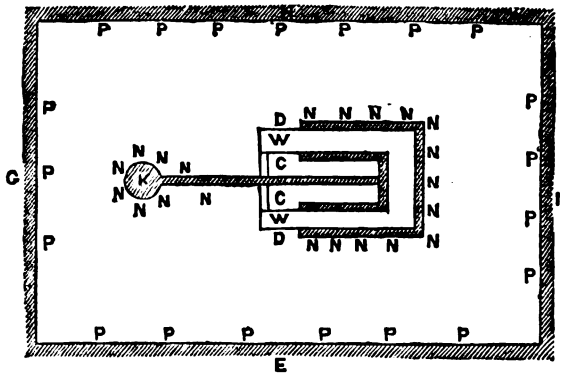
The outside coating, besides becoming charged on its interior side next the glass, becomes charged therefore on its exterior, the same as if it was the outside of a solid conductor attached to one pole of a source, the other pole of which is connected to the surrounding surface, or in fact to earth; the surrounding conducting surface having an equal quantity of opposite electricity disposed on it.

These two branch inductive circuits, in *these* cases, will not in the least affect the degree of accumulation on the surfaces of each, for we are supposing the source to be continually acting until all is in equilibrium, and I allude only to the state which will result when this equilibrium is established. The total resistance of the whole inductive circuit is less than if one branch alone existed, and thus the total quantity accumulated will be greater than with one alone; but the proportionate resistance of the two circuits to one another does not affect the final quantity that will be accumulated on the surfaces composing each, if a given source be made, or allowed, to act until all is equilibrium. The conditions under which branch circuits affect one another or not will be pointed out further on.

Suppose now we remove the source, and then break the connection between the inner coating and the surrounding surface, so that the jar is entirely insulated from the surrounding surface. We may now discharge with a discharging rod, having of course an insulated handle, the accumulation on the interior coating, and *inside* of the exterior coating, or, in fact, the electrical state existing between the two coatings (and which constitutes what is generally termed the *charge* of the jar), without discharging the quantity of negative electricity on the outside of the outer coating, some of which will pass by the discharging rod to the knob, K, and the electrical state that would ensue is represented in fig. 44. This state can only be annulled, therefore, by a connection between the knob and outer coating to the surrounding conducting surface, when the two equal quantities of opposing electricity will recombine and reduce all to the normal state.

If the inductive action goes on entirely and absolutely between two conductors, insulated from, but surrounded in all directions by, conductive matter in connection with the earth, then one of these conductors must contain the other, and in such case the dielectric separating the exterior conductor from the surrounding conducting surface does not form any part of the inductive circuit, and consequently no alteration in the resistance of the inductive circuit will be produced by connecting the exterior con-

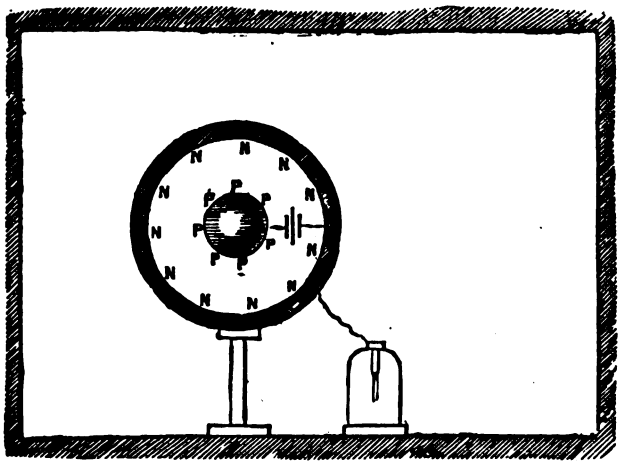
Fig. 44.



ductor with the earth, and consequently no alteration in the accumulation.

Thus, if the shell represented in fig. 11 be connected to the

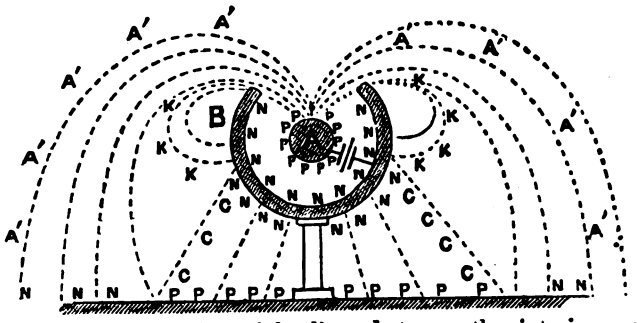
Fig. 11.



earth, no difference could take place in the resistance of the inductive circuit extending from one pole of the source to the other, and no electrical effect of any kind could ensue. For the same reasons if, in the insulated room experiment the room be connected to earth, as no inductive circuit is altered in any way by such connection, no difference in the quantity that could be accumulated on the prime conductor of the electrical machine could ensue.

Let us now suppose the conductors in the open air. If we suppose the inductive action to go on only in straight lines, and the suggestion of the outer opposing shell of air, as shown in fig. 27, to be incorrect, then if the exterior conductor, B (fig. 45),

Fig. 45.



simply intercepted all straight lines between the interior conductor, A, and the surface of the earth, no change in the resist-

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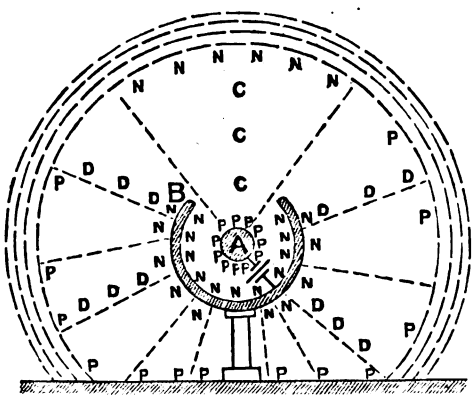
ance of the inductive circuit could be produced by connecting the conductor B to the earth, and no change in the accumulation could ensue.

If, however, we suppose the inductive action can go on in curved lines, then in such an arrangement the surface of the earth would become an intermediate conducting surface. So that an inductive circuit would in such case be formed from A along A′A′A′ to the earth, and thence by C C C back to the exterior of the conductor B. B would therefore be negative on its exterior, and the earth positive at the termination of C C C, and negative at the termination of A A. Connecting B to the earth would therefore annul the quantity previously existing on the exterior of B, whilst it would increase the quantity on the upper part of A, as that portion lays in the indirect circuit, which has been reduced in resistance, and would increase the negative charge on the surface of the earth. But this would not affect that quantity on A and the interior of B, due to the direct action between them. With this supposition of curved lines, if we suppose no limit to their degree of curvature, the outside of D might also become charged negatively through lines K K K, passing from A directly round to the outside of B without touching on the earth.

If my suggestion of the outer opposing shell of air be allowed, then even with inductive action in straight lines, an indirect circuit would exist, as shown in fig. 46, which can be traced from A along C C C to that part of the shell of air marked N N N, and from the parts of the same shell and the earth marked P P P, along D D D to the exterior of B, which would cause the conductor B to become charged on its exterior. In such case, therefore, the connection of B with the earth would produce about the same results as in the case of induction in curved lines.

Fig. 46.

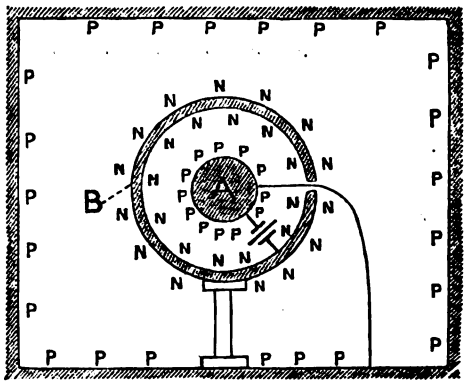


If the conductor A is entirely surrounded by B, as by the shell in fig. 11, then, whether the inductive action takes place in curved lines or not, or whether the shell of air boundary be admitted or not, no change in the electrical state within can result by connecting the exterior conductor B to the earth.

If the interior conductor A (fig. 47) when the shell B practically entirely envelopes it be connected to earth (by a connection through a minute aperture in B), a branch inductive circuit will be formed, and the exterior of the shell B will become charged either partially, or on all parts of its surface, according to the conditions existing exterior to it, just in the same way as if the source were itself exterior to the shell, and had one pole connected to B and the other to earth. If, for instance, B is surrounded entirely by a conducting surface, (as in fig. 47,) it will become charged on all its exterior surface, and if the outer boundary of the air suggestion be allowed, it will produce the same result. If, however, the conductor is in the open air, and the outer boundary of the air is not allowed, and it is only opposed therefore by the surface of the earth, then the queries of inductive action in curved lines or not, apply in the same way as if B were a solid conductor connected to one pole of a source, the other pole of which is connected to the earth.

Whatever may be the effect on the interior of B, whether it becomes charged on the whole of its surface or not, the accu-

Fig. 47.



mulation on the conductor A, and the interior of B will not, however, be in the least altered by the fresh inductive circuit, thus produced by connecting A to the earth. For the inductive circuit in which the surface of the conductor A, and the interior surface of the shell B, are comprised is not altered; it being clearly understood that the source is not withdrawn, and continues to act until all has arrived at equilibrium, as I have already specified when describing almost similar cases with Leyden jars.*

If in fig. 47 the source be placed exterior to B, and has one pole connected to the outer opposing surface D E F, and the other pole to the exterior of B, whilst A remained still in connection with D E F, it is evident the effect would be the same as that which results from the arrangement shown in the figure.

(To be continued.)

RANDOM PAPERS BY A PRACTICAL MAN.

I.—Earth Connections.

In the construction of telegraphs, one of the most difficult objects to obtain is frequently that which is technically called 'a good earth." An earth connection, to be good, must be in perfect and permanent contact with the moisture of the ground. In the explanation of statical phenomena, the earth itself may be considered as a vast "reservoir," ready to absorb or supply any quantity required of electricity; but in all dynamic phenomena, and in all the practical requirements of telegraphy, it must be looked upon as a simple conductor, but of infinite extent and of no resistance. As the earth is composed of various materials, some of which insulate, some of which conduct, it is essential that the terminal points of a telegraph grasp the latter, and avoid the former. In dry geological formations, such as chalk, lias, &c., this is very difficult. Simple insertion in the ground is not sufficient. Water, the true conductor of the earth, must be reached. A deep well, the bed of a river, &c., if near, are convenient; if distant, a wire must be taken to them.

Cases have occurred where a wire has to be erected some miles to attain this object. In towns the system of gas or water pipes prove completely effective, but in small country stations, where gas and water companies do not flourish, other contrivances are necessary. Large plates of copper or iron, bundles of old wire, old rails, pipes, &c., are called into requisition; but with all these contrivances, unless the moisture of the earth be well secured, success is absent.

Imperfect connection with the earth adds resistance to the circuit; it has the same effect as the addition of so many miles of wire; but it has the inconvenience of being a variable resistance, and the generator of disturbing causes, such as "gas currents," and other currents which are mistaken for "earth currents" or "deflections." When a single

* I mention this again, as it seems to me possible, that the action which I have described, might be confounded with that which would take place, if, after having charged any body and *withdrawn the source of generation*, we make any alteration in the arrangements of the conductors. In such case *redistribution* of the *electricity produced* will take place, which forms a different class of problems, some of which will be mentioned further on.

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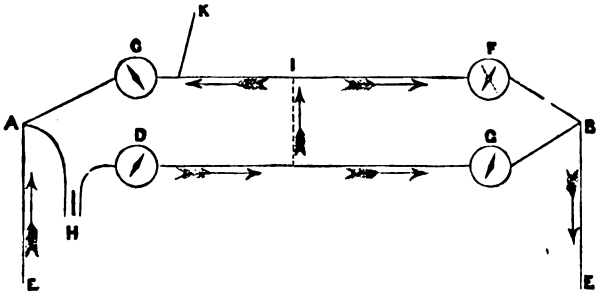
wire is employed, the inconvenience is not great; but when more than one wire is required, as in the case of a double needle, or a separate and independent circuit, a contact is the result. The current sent on one wire, in place of passing directly through the earth to the distant station, proceeds partially through the other wire, or wires, producing what is technically called a "cross contact." A contact is termed "*cross*" when the deflections of a needle on one wire is the reverse of that on the other; a "*direct* contact" occurs when the deflection on both wires is in the same direction. Contacts arise from many causes; such as imperfect insulation, some foreign substance on the wires, or the wires themselves infringing on each other.

But contacts occurring from "bad earth" are easily distinguishable from all these, and easily traceable by the following means:—



If the contact arise from any other means than a bad earth, it must occur between A and B. Say it be at I; then a current sent from H will show a *cross* contact on the needles C D, and a *direct* contact on F G. But if it result from a bad earth at A or B, then it will be *cross* at both places. To find out at which place it exists, put fresh earth on at K. Then if it be at A, the deflection of the needles will be either not effected, or it will be increased; if it be at B, it will be either reduced or destroyed. This plan offers a simple and infallible means of detecting the presence and position of a contact arising from "bad earth." At a large station, where many circuits terminate, bad earths are frequently caused by the employment of too small a wire between the instruments and the earth plate. Every means should be adopted to reduce the resistance of the earth wire. At the Electric and International Telegraph Company's head station, a large copper cable is employed between the instrument room and the "earth." An unsoldered joint may frequently produce the same effect. Indeed, there is no more fruitful cause of indifferent working on long circuits than that of carelessness in completing the joints of the wire. No permanent joint should ever be allowed to exist in a telegraphic circuit without its perfect continuity being ensured and maintained by careful and complete soldering. But this—*nous verrons plus tard.*

THE FAILURE OF THE ATLANTIC TELEGRAPH.

[Continued from p. 213.]

To the reports made by Mr. C. F. Varley and Mr. W. T. Henley upon the condition of the late Atlantic cable, at the time of its failure, we now append that by Mr. F. C. Webb, as communicated to the *Times* by the Secretary to the Company:—

I beg to forward hereunder a copy of a report from Mr. F. C. Webb, C.E., who is well known as having had considerable experience in the testing and examination of telegraphic cables, and who has just returned from Valentia, to which place he was recently deputed by the directors to proceed for the purpose of affording them the necessary information as to the present electrical and mechanical state of the cable.

My absence from London has prevented it from being sent to you sooner for the information of the public.—Yours truly,

GEORGE SAWARD, Secretary.

Atlantic Telegraph Company, Liverpool, Aug. 22, 1859.

To the Chairman and Directors of the Atlantic Telegraph Company.

VALENTIA, *Aug.* 10.

GENTLEMEN: According to your request I have made from Valentia a careful examination of the electrical state of the Atlantic cable. I made some tests for comparison on the various pieces of Atlantic cable in Messrs. Glass's premises at Greenwich during July 31 and August 1.

I arrived here on the 4th inst., and assisted by Mr. Collett, made experiments during the 5th, 6th, 8th, and 9th inst.

I find the lowest resistance shown to be 278 statute miles.

I find it is possible to increase this resistance up to 589 miles by sending a current for some time from six to 12-plate Daniell's batteries.

By experiments I have made on various kinds of constructed faults, I find that a fault which could be thus oxidized, so as to give (by reversal of the current) a difference of resistance equal to the difference obtainable on the cable—viz., 311 miles, must give a *minimum* resistance of about 16 miles.

When the fault is large, and thus gives little resistance, no great change can be obtained by reversing the battery; and, indeed, it is evident that when the connection between the line and earth is increased beyond a certain extent of surface, no difference in the resistance of the circuit can be obtained by reversing the battery.

When the fault is very minute, it can be almost perfectly sealed up by a copper current, but the resistance will still be very great, even with a zinc current.

My experiments show that a fault of about 16 miles, minimum resistance can be varied with certainty by reversal of the battery to the same degree as the fault in the cable, and that if the fault gives less resistance than 16 miles, it cannot be varied to that extent, while, if it gives more resistance, the variation cannot be produced with the same certainty, nor quite to the same degree.

Taking, therefore, the resistance of the fault and cable beyond the fault to be equal to 15 miles, this would bring the fault to about 263 statute miles from Valentia.

As I have no information of the return current due to different lengths of the Atlantic cable, which might have been observed and tabulated during the paying out of the cable, it is impossible to check the resistance tests accurately by the observed return current.

Comparing it, however, with the return current on the Cagliari and Malta and Corfu cables, and making, roughly, allowance for the increased size of the gutta percha in the Atlantic cable, I found it to be about what is due to the supposed distance of the fault.

I also made experiments on the return current with a wire leading to earth from the cable, and by placing resistances in circuit in this wire I could represent a fault close at hand and of varying resistance.

I found that in such an arrangement, when the artificial fault gave a resistance of 300 miles, the return current was only reduced about 22 per cent.

If the real fault, therefore, was close at hand, the return current of the whole length of perfect cable beyond the fault would be only reduced about 22 per cent. also.

I am of opinion that the observed return current is much less than 78 per cent. of the return current due to the whole cable, as it would be if the fault were close at hand, and of a resistance of about 300 miles, and that it coincides, as nearly as I can judge, with that due to the length shown by the resistance.

Again, when the artificial fault was made to represent a resistance of 260 miles, and then increased to 580, the return current only increased about 17 per cent., whereas when the real fault is increased to the same amount of resistance (by sending a copper current for some time) the return current increases about 80 per cent. This shows also that the return current is more influenced by the partial healing of the fault than it would be if the fault was a small one near at hand, and consequently tends also to confirm the supposition that the fault is distant, and offers, when at its *minimum*, little resistance.

I am of opinion, therefore, that a serious fault exists about 263 statute miles from Valentia, measured along the cable, and that the cable between that spot and this shore is comparatively perfect.

No tests from here can now decide where the cable is mechanically severed, since all attempts to detect the reception of the most intense currents from the opposite shore have long since proved fruitless.

Still, from the various circumstances attendant on the decline of the insulation, there is every reason to believe that the continuity both of the cable and the conductor is perfect.

Whether any other faults exist beyond the one alluded to, it is impossible to ascertain by tests from Valentia.

The fact that the signals received at Valentia were always better than those received at Newfoundland proves undoubtedly that the worst insulation has always been near Valentia; and therefore it seems probable that if the fault which exists on this coast, and which, very likely, forms the principal cause of leakage, could be removed, the insulation would be so far improved as to render the cable again available for signalling, provided the fault which is said (by those who have tested from Newfoundland) to exist in Trinity Bay, was also repaired.—I have the honour to be, gentlemen, your obedient servant,

F. C. WEBB.

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The Student.

In compliance with the request of one of our correspondents, we propose to offer some observations upon the employment of the metal iron for the positive, as well as for the negative, element of the voltaic couple.

It is probable that *pure* iron would prove an excellent positive, superior even in some respects to zinc. Pure iron, however, is never met with in commerce, being found only in the laboratory of the chemist. Commercial iron invariably contains carbon and silicium; sulphur, phosphorus, cobalt, chromium, calcium, potassium, and sodium, occur more or less frequently among its impurities. The circumstance that iron undergoing solution in acid becomes covered with a layer of carbon, favours the employment of the metal as a negative, but impairs to some extent its practical utility as a positive element. It may be stated at the onset, that the properties of the compounds of iron and carbon met with in commerce do not interfere with the generation of a current of great *quantity*, but cause the *tension* of the current from a couple constructed with iron elements to be extremely feeble; thus necessitating, in most cases, a considerable number of alternations for the purpose of increasing the energy of the current. This fact should be borne in mind by those who, from motives of economy, propose the use of the metal iron in battery arrangements. The experimentalist, as we shall have occasion to show, may construct a battery which, in short circuit, may powerfully deflect the galvanometer, or heat several inches of iron wire to redness, but which, from the want of tension, may be almost useless even for electro-deposition, and quite so for telegraphic service. On the other hand, those who test the power of a battery couple upon a telegraphic circuit, or with a galvanometer coiled with a long length of fine wire, may often overlook the advantages of an arrangement which, from its cheapness and the great quantity of electricity set in motion, would be susceptible of useful application.

By substituting, in the small Daniell cell we have recommended for experiment, a cylinder of thin sheet iron for the zinc element, and a strip of the same iron for the copper element, filling the porous vessel with strong nitric acid, and exciting the iron with a mixture of one part sulphuric acid to four of water, a battery couple may be constructed, giving in short circuit a current of enormous quantity. This small electro-motor will heat an inch of fine iron wire, give the voltaic spark when contact is made and broken in mercury, and excite an electro-magnet coiled with stout wire. In all applications, however, where a greater amount of resistance has to be overcome, experiment readily shows that this couple is greatly inferior to that of Daniell. If, for instance, a few yards of fine iron wire be interposed in the circuit; the deflection of the galvanometer in the case of the iron battery will be greatly reduced; and, by augmenting the resistance, the deflection will soon become almost inappreciable. The same rapid reduction of the quantity of electricity passing through the circuit occurs when a fluid resistance has to be overcome, as in electro-deposition of metals. It is true that increased tension to any degree is to be obtained by connecting together, by their opposite poles, a number of the iron elements; but in so doing the question of economy must be kept in view, and the result compared with that we should obtain simply by increasing the surfaces in a Daniell arrangement.

When the iron battery we have constructed has been in action for a certain time, and the strength of the nitric acid has become reduced by combination of a portion of its oxygen with the hydrogen evolved from the negative element, the latter suddenly becomes acted upon by the acid with great rapidity. When removed for a time from the acid, the iron occasionally regains its negative properties, which appear to be due to a superficial coating of an oxide of the metal, protecting it from chemical action. This effect of chemical action occurs in much less degree when a highly carbonized iron, such as ordinary cast iron, or cast iron to which a further portion of carbon has been added during fusion, is used for the negative element. The chemical action upon the iron negative appears to further the exhibition of quantity in the current, but is also the cause of the reduced tension; the latter property being dependent upon the difference in the affinities of the existing fluid, or fluids, for the elements of the couple respectively.

In the Daniell and Bunsen batteries the same quantity of electricity may be set in motion, through a short circuit, when the metal iron is substituted for zinc as the positive element. We have found, however, in every case where the iron of commerce was employed, that the tension of the current was considerably reduced. It is, therefore, a question, whether the loss of tension occurs to a sufficient extent to interfere with the question of economy in using iron, in lieu of zinc, for the positive element in voltaic batteries.

With carbon in nitric acid for the negative, in lieu of cast iron, soft iron being used for the positive element, the quantity of electricity set in motion is less; but the tension is somewhat higher. When zinc is substituted for the positive iron, the tension is further increased; the arrangement being then that of Bunsen.

REPORT OF THE DIRECTORS OF THE SUBMARINE TELEGRAPH COMPANY.

It will be remembered, that a reduction of 50 per cent. on the tariff of the French and Belgian Lines was made on the 1st of February 1861, and that the natural consequence of such reduction was an immediate decrease of the company's receipts. The number of messages, however, transmitted during the last six months of 1861, amount to 127,163, being 24,710 messages in excess of the number sent during the previous half year; while the receipts for the same period have reached the sum of £17,119 14s. 8d., showing an increase of £2,084 6s. 1d over those of the previous six months; and being within £2,151 14s. 1½d. of the earnings of the half year ending December, 1860, the largest ever received by the company, that being the last half year's revenue before the 50 per cent. reduction. Thus within the short period of one year, the decrease in receipts, arising from the alteration of charges, has been almost compensated by the large addition of traffic, which is most satisfactory evidence that the public are already availing themselves of the advantages afforded by the establishment of a cheaper rate of telegraphic communication with the Continent,

Considerable repairs have been made to the Ostend and Calais cables during the past autumn and winter. An accident has again occurred to the former—but fortunately, so near the coast that it will be remedied at a comparatively small expense. With this exception, all the cables belonging to the company are in good working order, and a large portion of the French business is now transmitted by the Dieppe line.

In consequence of the late change in the accountant's department, of which the proprietors are aware, the directors have during the past year instituted a searching scrutiny into the accounts of the company from its constitution. From this investigation it appears that partly owing to disputed tariff accounts with the French Government, and partly to other causes, including items continued from time to time to the credit of revenue, which have since proved to be erroneous, a considerable sum is found to be due from the revenue to the capital account. By the new arrangement with the foreign Governments, all the accounts are now settled quarterly, instead of annually (as was formerly the case), to the mutual advantage of the continental authorities and this company. This alteration, together with the establishment of a bi-monthly audit, will effectually protect the company against the recurrence of similar errors.

The directors consider that to maintain the position and credit of the company there is only one way of meeting the case, viz., to refund the amount from the earnings of the company, and with this view they propose to open a suspense account, and liquidate the amount by instalments.

The annexed accounts exhibit a satisfactory increase in the company's revenue, but the errors, before alluded to, prevent the directors from recommending the payment of any dividend for the past half year. The investigation into all the former accounts (which it was impossible to complete in time for this meeting), will enable the auditors to settle the exact amount which is to be carried to the suspense account; but, in the mean time, the directors have submitted the accounts in their present shape for the information of the shareholders, and they believe that when the examination is terminated, there will be very little material difference in the figures.

The directors also consider it advisable that the reserve fund should be increased to 10 per cent. on the gross earnings of the company, instead of on the net profits, which latter amount they consider inadequate to meet the average cost of repairs to the cables,

In conclusion the directors are happy to be able to inform the shareholders, that they have obtained from the Belgian Government a renewal of their concession for the same length of time as that granted by the French authorities. The proprietors will not fail to appreciate this act of liberality on the part of the Belgian administration, which, by extending the company's privileges for a period of nearly 30 years, has materially improved the value of their property. The successful completion of the line between Malta and Alexandria, the further development of the Magnetic Company's system in England especially in the Western Counties, and the large influx of continental visitors which may be expected from the opening of the Exhibition,

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all tend to create new and remunerative traffic, and the directors trust (should no unforseen event occur) that at the half yearly meeting in August they may be enabled to recommend the payment of a fair dividend to the proprietors.

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

Fine	2s. to 2s. 2d.	per lb.

INDIA RUBBER.

Fine Para	1s. 11d.	per lb.
Negro	1s. 0d.	„
Java	1s. 4d. to 1s. 5d.	„

March 13, 1862. WM. KIRKMANN.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
5	London District Telegraph .	4½	4 to 3¼ dis.	———
Stock	Electric Telegraph . .	100	96 to 99	———
20	Red Sea and India Telegraph	all	18¾ to 19¼xd	———
1	Submarine Telegraph, scrip.	all	3/8 to ⅝	———
1	Do. registered . . .	all	3/8 to ⅝	———
10	Do. „ . . .	all	4 to 6	———
5	United Kingdom Telegraph .	2½	1½ to 0½ dis.	———
10	Mediterranean Extension Tel.	all	4 to 5	———
2	Telegraph to India . .	1	⅛d. to ¼ pm.	———

Telegraphic News.

INDIA.

THE Indian Government proposes erecting a second telegraph wire between Calcutta and Bombay, in consequence of the large and increased traffic on the present single line of telegraphic communication between the two cities.

AMERICA.

A SUBMARINE cable was about to be laid from Fortress Monroe to Cape Charles, thereby completing the telegraphic communication with Washington and New York.

In the United States Senate, on the 17th ult., various petitions were presented. Mr. Latham reported his bill, authorising a survey, with a view to constructing a telegraph line across Behring's Strait.

The President of the Federal Government has taken possession of all the telegraphic lines, and military supervisors of messages have been appointed.

The following order has been issued by the War Department:—

"*War Department, Washington City, D.C., Feb.* 25.

"Ordered—1. From and after the 26th day of February inst., the President, by virtue of the Act of Congress, takes military possession of all the telegraph lines in the United States. 2. All telegraphic communications in regard to military operations not expressly authorised by the War Department, the General commanding or the Generals commanding the armies in the field, in the several departments, are absolutely forbidden. 3. All newspapers publishing the military news, however obtained, and by whatever medium received, not authorised by the official authority mentioned in the preceding paragraph, will be excluded thereafter from receiving information by telegraph, or from transmitting their papers by railroad. 4. Edward S. Stanford is made military supervisor of telegraphic messages throughout the United States. Anson Stager is made military superintendent of all telegraphic lines and offices in the United States. 5. This possession and control of the telegraphic lines is not intended to interfere in any respect with the ordinary affairs of the companies, or with private business.—By order of the President,

"EDWIN M. STANTON, Secretary of War."

PRUSSIA.

A LINE of telegraph has recently been established between the Royal Palace, Berlin, and the barracks, so as to ensure immediate assistance in case of any danger to the person or the dwelling of the King.

THE LONDON AND SOUTH OF IRELAND DIRECT TELEGRAPH COMPANY.

THE advantage to be derived from the concession obtained by this Company for a telegraph station at Roche's Point, at the entrance to Cork Harbour, where the pilots reside, and whence they board the steamers, was exemplified on the 10th instant by the receipt of the news brought from New York by the Cunard steamer *Asia* some time before it could have been transmitted from Queenstown.

THE LONDON AND QUEENSTOWN DIRECT TELEGRAPH COMPANY (LIMITED).

THIS Company, which is in connection with the Electric and International Telegraph Company, is progressing rapidly with the construction of its lines for both land and submarine purposes. The submarine cable to be laid between St. David's Head and Wexford is nearly completed. The Company have made arrangements for the establishment of stations at the following places:—Cork, Duncannon, Waterford Harbour, Pilot Office, Queenstown, and Tramore; and stations at other intermediate towns are to be established. The arrival of the American mails will be thus communicated, not only to the metropolis, but to all the capitals of Europe, by means of the Electric and International Telegraph Company's wires.

Law Intelligence.

VICE-CHANCELLOR'S COURT, MARCH 8.

(*Before Vice-Chancellor Sir* W. P. WOOD.)

THE ELECTRIC TELEGRAPH COMPANY *v.* THE UNIVERSAL PRIVATE TELEGRAPH COMPANY.

This was a motion for an injunction to restrain the defendants from introducing or establishing, during the continuance of their agreement with the plaintiffs, their system of private telegraphic communication within any city, town, or district of Great Britain or Ireland, otherwise than in connection with the plaintiff's system, and subject to the provisions of the agreement entered into between the two companies.

The case turned upon the construction of the agreement between the complaining and defending companies, which was dated the 3d of September, 1861. This agreement, after reciting the objects and powers of the two companies, and that the directors considered that it was for the mutual advantage of their two companies that the system of telegraphic communication proposed to be established by means of the Universal Private Telegraph Company should be placed in connection with the system of telegraphs used by the Electric Telegraph Company, contained various provisions for carrying out the arrangement, the most material of which are in substance as follows:—The system introduced by the defendants within any city, town, or district in Great Britain and Ireland was for seven years, the term of the agreement, to be exclusively in connection with the system of the plaintiffs. The plaintiffs to receive into their stations the apparatus of the defendants. The defendants, in introducing their system in any place with which the plaintiffs' system is in communication, not to work in conjunction with any system other than that of the plaintiffs. Messages for foreign countries to be handed over by the plaintiffs for transmission by other companies where greater facility and convenience will be thereby obtained. The defendants to be allowed to contract with the Submarine Telegraph Company, or any company having direct communication with the Continent, for press despatches for the newspapers, but for no other purpose. The system of the defendants to be limited to private telegraphs only, and not to be used or worked by any person, except such persons only as shall require and engage to use or work the same for receiving or transmitting messages connected with the business affairs of the persons so using the same. The defendants, without the consent of the plaintiffs, not to permit any person to use their apparatus except under this restriction. The plaintiffs, without the consent of the defendants, not to establish any system of private telegraphs in any place where the defendants' system is in operation; but the plaintiffs not to be restricted in extending their system. The plaintiffs, so far as possible, to support and assist the defendants in introducing and establishing their system in any place in the United Kingdom to which the powers of the plaintiffs extend.

The bill, after stating preparations by the plaintiffs for laying down a submarine cable between Haverfordwest or Milford and Wexford, so as to extend their system across the Channel to Ireland, including Cork and Queenstown, averred that the defendants had commenced introducing their system within the same district, but in connection with the London and South of Ireland Direct Telegraph Company, recently established for the purpose of providing a direct and unbroken line of communication from London, *vid* St. David's Head, across the Channel to Wexford, and thence by Waterford to Queenstown. The plaintiffs had filed their bill to restrain the defendants from carrying out their arrangements with the London and South of Ireland Company, in alleged breach of their agreement with the plaintiffs, and now moved for an interlocutory injunction.

Mr. Rolt, Sir Hugh Cairns, and Mr. Fooks appeared in support of the motion; Mr. Willcock, Mr. Daniel, and Mr. Freeman, on behalf of the defendants, opposed the motion.

The arguments turned upon the construction of the agreement, and it was also urged, on behalf of the defendants, that in places where the plaintiffs had not established their system, so as to afford a direct communica-

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tion with London or the great centres of commerce, the defendants ought not to be prohibited from using the direct communication afforded by any other company, without the necessity of breaking the message, which would be occasioned by limiting them in such cases to the plaintiffs' system.

The Vice-Chancellor said that he should put both parties upon an undertaking, and should abstain from deciding anything beyond what was absolutely necessary for the purposes of the interlocutory application. The question turned upon the construction of the agreement, and the agreement only, and it was much to be regretted that a quantity of extraneous matter—charges of improper conduct, &c.—had been imported into the case. He might at once say that the plaintiffs did not rest under the slightest imputation for anything that they had done since the date of the agreement, and there was not the shadow of pretence for ascribing to them any breach of good faith. On the other hand, the defendants stood equally absolved from any such imputation, for whatever they had done had been done openly and with perfect candour. At the present stage of the proceedings he was not prepared to say that when the communication afforded by the plaintiffs was imperfect or broken the defendants might not make their own arrangements with other companies for a direct transmission of their messages, so as to avoid the gap necessitated by the use of the plaintiffs' system. The agreement contemplated many cases in which the plaintiffs would be unable to transmit messages the whole distance—to foreign parts, for instance—and that such messages might be transmitted by other companies with whom the plaintiffs might be in communication. Then, again, he had no power of compelling the plaintiffs to make their communications perfect. He could not, therefore, go to the extent sought by the notice of motion of restraining the defendants from using any communication but that afforded by the plaintiffs. The defendants must give an undertaking, in reference to any mode of telegraphic communication to be introduced or established by means of their system between Great Britain and Ireland, in the terms stated in the agreement, not without the consent of the plaintiffs to let or appropriate, or permit any person to use their wires or apparatus except (as already stated) for receiving or transmitting messages connected with the business affairs, &c., of the persons so using the same. The effect of this would be that the defendants would not be entitled to allow persons to use their stations or wires for public purposes, and they would not be restricted to the route by Haverfordwest. The plaintiffs would also be put upon an undertaking to receive at Haverfordwest the wires, &c., belonging to the defendants' system. No further order upon the motion. Costs to be costs in the cause.

NORFOLK CIRCUIT.

AYLESBURY, March 10.

Nisi Prius Court.—(*Before Mr. Baron* Martin *and a Special Jury.*)

THE QUEEN *v.* THE UNITED KINGDOM ELECTRIC TELEGRAPH COMPANY (LIMITED).

Mr. Mills, Q.C., and Mr. Metcalfe were for the prosecution; Mr. O'Malley, Q.C., Mr. Keane, Mr. Joseph Chitty, of the Chancery bar (specially retained), Mr. Lathom Browne, and Mr. Stephenson appeared for the company.

This was an indictment preferred and found at the last quarter sessions for this county, and moved by *certiorari* into the Court of Queen's Bench, charging the defendants, in eleven different counts, with obstructing the highway in the parishes of Denham, Iver, Chalfont St. Peter's Beaconsfield, &c., by erecting telegraph posts thereon, "to the great damage and common nuisance of all the Queen's subjects."

The defendants pleaded "Not Guilty."

It is understood that this is one of a series of indictments preferred against the defendants in the counties of Middlesex, Buckingham, Oxford, and Warwick, and that in the county of Oxford the indictment has been ignored by the grand jury. The indictment in Warwick is expected to come on for trial at the coming assizes for that county.

The trial here was commenced at 12 o'clock on Saturday, and the opening statement of the counsel for the prosecution, the formal proofs, and the examination and cross-examination of a surveyor called by the prosecution, occupied the whole of that day. It appeared that the matters to which these indictments relate are also before the Courts of Chancery, and books of photographic views of nearly every individual post set up by the defendants in this county were produced both by the prosecutors and the defendants, and referred to by both sides, and by the Judge and jury, as explanatory of the evidence given by the witnesses.

At the sitting of the Court this morning Mr. Baron Martin stated that since the adjournment on Saturday he had given the case his most serious consideration, and that, in order that there might be no mistake, and that no question might hereafter be made about his ruling, he had prepared a written paper containing a statement of what he believed to be the law applicable to the present indictment; that he was now prepared to state how he should direct the jury; that it might be he should also have to direct them as to other matters, but, speaking of a common ordinary road, such as he himself had seen yesterday, and which, no doubt, was of the character of great portions of the roads on which the defendants' posts were placed, he (the learned Judge) believed the law to be as follows:—

1. In the case of an ordinary highway, although it may be of a varying and unequal width, running between fences on each side, the right of passage or way, *primâ facie*, and unless there be evidence to the contrary, extends to the whole space between the fences, and the public are entitled to the use of the entire of it as the highway, and are not confined to the parts which may be metalled or kept in repair for the more convenient use of carriages or foot passengers. 2. That a permanent obstruction erected on a highway, and placed there without lawful authority, which renders the way less commodious than before to the public, is an unlawful act, and a public nuisance at common law; and that, if the jury believed the defendants placed, for the purpose of profit to themselves, posts with the object and intention of keeping them permanently there in order to make a telegraphic communication between distant places, and did permanently keep them there, and the posts were of such size and dimensions and solidity as to obstruct and prevent the passage of carriages and horses or foot passengers upon parts of the highway where they stood, the jury ought to find the defendants guilty upon this indictment; and that the circumstance that the posts were not placed upon the hard or metalled part of the highway, or upon a footpath artifically formed upon it, or that the jury might think that sufficient space for the public traffic remained, are immaterial circumstances as regards the legal right, and do not affect the right of the Crown to the verdict.

Mr. O'Malley then stated that he should wish to consult with his clients as to the course to be pursued.

The counsel and solicitors for the defendants then left the court, and on their return,

Mr. O'Malley said that, such being his lordship's view of the law, if the jury were to be so directed and the question so left to them, it would be useless for the defendants to hope for a verdict on this indictment, that he should therefore abstain from calling the evidence with which he was prepared, and which would, in many respects, completely contradict that already given by the prosecution, and that he should move the Court of Queen's Bench on his Lordship's ruling, which, according to decided cases, he believed to be erroneous.

His Lordship then briefly summed up the evidence given by the prosecution, and directed the jury in accordance with the view he had already expressed.

The jury at once returned a verdict for the Crown.

This concluded the business of the assizes for the county of Buckingham.

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

ON SUBMARINE CABLES.

To the Editor of The Electrician.

Sir,—We have seen the importance of carefully avoiding anything approaching to moisture, or even a damp atmosphere, in the process of applying the insulating material to the conductor, from the fact that humidity coming between the two, oxidization of the copper, and ultimately total destruction of the insulator. This being the case, the insulation of the core for submarine cables assumes supreme importance. It is evident that in order to guard against a similar contingency, after submersion, an insulator should be used which combines with lasting durability, permanent non-absorbent qualities, together with a compactness and homogenity which shall effectually exclude from the wire the veriest infinitessimal particle of the aqueous element. Now gutta-percha is notoriously at fault in this respect: a porous substance is necessarily an absorbent; and although a considerable period would probably elapse before so undesirable a consummation would have arrived, from the extreme minuteness of the pores, still its destruction from that cause, although remote, is as certain as that to-morrow's sun will rise.

Now pure caoutchouc, properly applied, supplies this desideratum; and it is the only insulating material at present known that really does.

Compounds should be utterly repudiated, whatever may be the materials which enter into their composition, or the distinguished names by which in part they attain to celebrity—simply because they are proved by experiment to lack the essential qualities of durability and perfect insulation; and also from the immutable law that for the restraining of all natural forces, nature ever provides from her own ample laboratory the requisite antipodal elements, even as all noxious elements are provided with their antidotes from the same bountiful and beneficient source.

This matter assumes a tenfold importance when we consider that submarine telegraphy is an enterprize on which is staked sums of money, which our forefathers would have deemed fabulous; and could they again "revisit the glimpses of the moon" would probably think we had become incurably insane in thus literally throwing into the sea what would once have purchased the fee-simple of half a kingdom.

If it then be of such great importance to secure a core which shall be the *ne plus ultra* of insulation, it is of no less importance that the outer covering or sheathing should be the very best of its kind, *i.e.*, a protective covering in every sense of the word.

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But the views and notions hitherto held on this subject are as crude and illogical as those so rigidly adhered to with respect to the material and general construction of the core; and, irrespective of failures, quite as obstinately persisted in, as though perforce we had cleared at a single bound all the intervening space of dreary morass and tangled brushwood which lies between the first dawning perception and the far distant future, where our painful and wearying process of labour and thought is consummated in a fruition which even then never realizes the ultimatum of our anticipations and desires. Truly it is unbecoming of us as a sober, non-impulsive, and practical people, who value things only at their real worth, to cry "Eureka! Eureka!" prematurely. True, we live amazingly fast, compared with our mole-like forefathers, and there are very few of us, I dare say, whose horizon is circumscribed by the few miles which encircle our native village; but notwithstanding we may journey to the antipodes and back in less than a twelvemonth, and "put a girdle round the earth in less than forty minutes," and talk with the natives of Timbuctoo as our next door neighbours; I have yet to learn that there is any other way to the attainment of knowledge, and the working out of grand results, than the old, old, weary way through the labyrinthine maze, strewn indeed with the wrecks and ruins of long lives rendered abortive, and works gigantic in their shapelessness, where, having mistaken the numberless paths, interminable in their sinuosities, leading to nowhere but chaos and confusion, the blinded votaries of science have wandered in a land of shadows; the way leading over the "hill difficulty," and through the "valley of humiliation," where we often diverge from the right path, allured by some false meteor, and have to retrace, and re-retrace, the dusty road, made still more difficult by our own obstinate bungling, in assuming that we know everything, and require no teaching; the way, in short, which has consumed rivers of oil in monkish cells, and a myriad of lives, of which history has left no record.

Truly electricians and telegraphists would do well to learn a lesson of modesty and humility from the past. Here is a science of which we know comparatively nothing; in its infancy, a thing of yesterday, which we have just succeeded in putting into swaddling-clothes, and yet we bluster, and are as positive and dogmatic as though we knew all about it, and that there were no secrets of nature with which we were not thoroughly conversant.

Were I, in maintaining the superiority of pure rubber over all other insulators, to assert, that in that nature had reached its limit, and provided its maximum for the especial purpose in question, I should, indeed, prove myself as absurd as though I should say, that this "Wave o'erhanging firmament fretted with golden fire" revolved around us, and was created for the express purpose of lighting up this insignificant spot in the universe which we call earth.

I have been led to make these remarks from the fact, that iron-sheathed cables, having been once adopted, are accepted, and held to be the very acme of human ingenuity, and, I may almost say, perfection, as a protective covering. If you ask, Why? probably echo will return you an answer; it is certain no one else can answer the question more satisfactorily; for it is manifest that the iron sheathing, with all its virtues, has had something to do with the failures of every cable of any great length hitherto submerged. Why it should, may be easily understood by the merest novice. A gentleman well acquainted with the process of paying out a cable at sea, states that a cable thus constructed will descend with a rush sufficient of itself to strain and damage the core it was intended to protect. And the mode of covering the core spirally with the iron wire constitutes its greatest defect; in paying out such a cable, averaging in weight from 2 to 4 tons per mile, it must necessarily tend to elongate the wire sheathing, and if it should do so only to the extent of 1 inch in a mile: consider for a moment the effect it must have upon several miles when the whole weight falls upon the core which was never intended should bear weight at all! The consequence is that sooner or later, the core, having thus been strained to such a degree of tension, must suffer in its insulating and conducting qualities, the sure prelude of an early and total collapse.

Iron is an excellent material with which to do the rough work of the world, nothing better in fact; and to it, in a sense, we owe our pre-eminence among the nations of the earth. It is a mighty lever of civilisation in the hands of an industrious, ingenious, and enterprising people. But it is possible to misapply it, and I humbly opine, that in using it as the sheathing for submarine cables it is egregiously misapplied.

True it affords strength, supposing the strength thus afforded is not rendered abortive by the spiral method of covering; but granting it perfect in this respect, there are other substances which may be used that will answer the purpose equally as well, if not better, without the cumbrous weight which the use of the former involves.

True again there are no monsters in the sea's fathomed and unfathomed depths with maws sufficiently ravenous to digest galvanized iron wire; but that is not the only commodity which enjoys immunity from the same inglorious fate, supposing, for the sake of argument, the same marine monsters, however minute, have any existence out of the land of fable; while at the same time these latter are not subject to the attacks of that all-devouring monster, rust, which evinces an extraordinary appetite for the metal in question.

True, also, that the enormous weight of iron sheathed cables secures their unmistakable deposition on the bed of the ocean, save when a sudden dip occurs of a few extra fathoms, when it will hang suspended across a huge gulf to the imminent destruction of the core, which will then, in all probability, be called upon to fulfil a duty which its faithless protector is unable to perform. But then a cable formed of other materials quite as durable and protective, may, by a gradual descent through the "fishy flood," secure the same desirable resting place, which once attained, being but little more than a fourth of the weight of an iron sheathed cable, suffers but little or no strain, and none at all on the core if properly constructed, so that when once submerged, whatever the nature of the bottom may be, the buoyancy of the the water is a support of itself, and its calm depths, which are never disturbed by the storms which lash the surface into fury, secures it also from abrasions on rocky bottoms, where such exist.

The failure of the Atlantic cable had the effect, as all huge failures have, of introducing to notice a host of new inventions, each one held by its inventor to possess the requisite qualifications which the unfortunate one above named is said to have lacked; each one of these will probably pass under notice as we proceed with the subject, a subject than which nothing can be of more importance to the world at large, and Great Britain in particular.

Momus.

TELEGRAPHIC "FAULT."

To the Editor of The Electrician.

Sir,—I met with a singular "Fault" the other day on a Double Needle Circuit of three Stations.

Each station could move one needle either way. But no one of the three could move the right needle to the left, that is, no station could send or receive the letter H.

There could not have been earth on one pole of the battery, for, apart from the improbability of each of the three stations being thus *faulty*, had it been so they could have moved the left needle one way only.

This fault came on on several different occasions, fine and wet weather, and lasted from ten minutes to six hours, always going off spontaneously.

I proved the fault to be near one of the terminal stations, and traced it to about three feet of wire. That I cut out, together with the iron arm in which the wire was cemented; and upon testing it when laid upon a table the symptoms I state above were plainly visible.

I should be glad if one of your readers could explain the cause, and have ventured to trouble you with this letter, because I think, and so do many of us, that if we could glean a little *practical* knowledge from your pages many more of us would subscribe.

Inspector.

SECONDARY CURRENT OF POLARIZATION.

To the Editor of The Electrician.

Sir,—I have met with a curious case of current of polarization. A quantity of short lengths of fine silk covered copper wire had been soldered up and wound on a reel. The joints were left bare, and the coil laid in a damp place.

On passing a current through it for a minute, and then connecting it with a galvanometer, a reversed current flowed for many seconds. The effect ceased when the coil was laid in a dry room.

An Old Hand.

TUNNEL TELEGRAPHS.

To the Editor of The Electrician.

Sir,—In reply to your correspondent "Inquisitive," he will find, on referring to the published evidence of the celebrated enquiry into the Clayton Tunnel accident, and also to Captain Tyler's report to the Board of Trade, that the instruments used were ordinary single needles and the common electric alarum.

Similar instruments are employed in hundreds of cases, and any improvement upon them would be received with great satisfaction by the railway world. I shall anxiously look out for the promised communication from "Inquisitive."

Telegraphist.

March 11, 1862.

To the Editor of The Electrician.

Sir,—In your number of the 7th inst. I observe a communication signed, "Inquisitive," relating to the signals used in the tunnel on the Brighton line, at the time of the accident, a few months ago.

As far as I recollect, the signals were given from one man to another by the ordinary telegraphic means, and the acoident occurred owing to the parties misunderstanding the signals.

This accident would, in all probability, have been avoided, had "Gibson's patent self-acting signal and electro-galvanic alarum bell" been used. This apparatus was fixed by Messrs. Young and Pool, of Hull (the proprietors of the patent), in August, 1857, at the junction of the passenger and luggage line, about two miles from Hull. The patent is expressly adapted for tunnels, as the engine, on entering the tunnel, or passing the distance signal, turned on the danger signals, and rings an electro-galvanic alarum-bell at the nearest station, or pointman's house, and the bell continues ringing until the train emerges from the tunnel, or passes the near signal.

A model of this invention was exhibited before the British Association,

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at Leeds, and, for the safety of the public, it is to be hoped the invention will, ere long, be generally adopted.—I am yours obediently,

Thos. W. Stears, Electrician.

Hull, March 11th, 1862.

THE VOLTAIC BATTERY AND THE INDUCTION COIL.

To the Editor of The Electrician.

Sir,—I am obliged by your answer to my enquiry in your last. You remark that you have not been able to produce the same effects from iron as a positive metal, and think that it must be in consequence of the difference of the iron. The only iron I have used has been sheet iron, about $\frac{1}{4}$-inch thick and that which is used for making stove pipes. Perhaps it is necessary in using iron to have a larger negative carbon pole; the one I have in use is eight inches high and two in diameter, this with the iron plate exposing one square foot of surface, the plate of iron being 24 × 6. This battery with the coil I have previously described gives through the primary wire (one pound of copper wire), wound on in three lengths, very bright crepitating sparks $\frac{1}{16}$-inch long. When the battery ceases to work I add *more water*, which may be done up to a certain time when more acid will be required.

The coil I have alluded to, the secondary wire of which consists entirely of about 330-feet iron wire No. 18, and with a condenser exposing two square feet of tin foil, gives a bright snapping spark at the ends of the secondary wire, and will powerfully charge a Leyden jar or condenser, will give such powerful shocks that are quite insupportable for a very short time. I have not tried this coil with any other battery than the one mentioned, no doubt it would be more powerful if used with three or four Bunsen's or Grove's battery, but I have not the opportunity of trying it with them. If I am not troubling you too much, I wish to ask you two or three questions. First—As I have obtained such good effects with iron wire in so small a proportion for the secondary wire, would it be possible to construct one as powerful as the one described in "Noad" on the "Induction Coil?" Secondly—Has the secondary wire any proportion to the primary in length, or will the secondary effects cease after a certain length is on, and if so, why? Thirdly—Would it be better to put the secondary wire on in separate layers, as is done with the primary, and collecting all the ends on each side of the coil together; or would it be necessary to bring each end alternately to the opposite ends of the coil, as in putting them on in separate layers there would be induced and inverse induced currents in contrary directions, but by joining the ends as mentioned they would all be brought to the secondary terminals in one direction? And lastly—Is it absolutely necessary that the iron wire I use for the secondary should be of the size mentioned, as I imagine the effect decreases the further off the secondary wire is from the primary? If you can kindly furnish me with these particulars, I shall deem it a favour.—Yours respectfully, J. Cook.

P.S.—In my next I think I can give you a description of a self-acting contact break, for magneto machines, worked by the magnet itself, requiring no manual labour, and perfectly continuous.

[We will endeavour to answer your questions respecting the induction coil in our next. The iron positive may give as much quantity in the current as the zinc; but the tension is much lower.—Ed. E.]

DURABILITY OF GUTTA PERCHA AND INDIA RUBBER IN WATER.

To the Editor of The Electrician.

Sir,—Can you or any of your readers inform me of an instance where either of the above gums, when pure, has deteriorated in its insulating powers when submerged in water?—Yours, L. T.

[We have examined pure gutta percha cores which had been submerged from six months to ten years, and upon electrical examination we found their insulating powers unimpaired. We have also recently examined a piece of india rubber core, a portion of a cable supplied by Messrs. Hall and Wells, for the Government experiments, which had been in water for upwards of two years and a half, and we found its insulating capacity unimpaired.—Ed. E.]

Miscellanea.

The Electric Telegraph and National Defences.—We quote the following from the speech of the Chairman of the London and South of Ireland Direct Telegraph Company (Lord Fermoy) in Parliament on the Defences of Irish Harbours:—"The navy of the country ought to be its right arm in case of invasion. His conviction, therefore, was, that instead of placing a few guns on a rock at Belfast, at Cork, and elsewhere, which might be taken by an enemy, and perhaps afterwards turned against the harbours they were meant to defend, they should fix on certain points along the coast at which gun-boats should be stationed in time of war, and which should be provided with telegraphic communication. He would, for instance, place Cape Clear, in the west, in telegraphic communication with Cork, where a fleet of gun-boats should be stationed, which could start in pursuit of any invading vessels at a moment's notice. Another suggestion which he considered of importance was this—that the lighthouses should be provided with facilities for telegraphing from one to another. Thus, on a suspicious-looking ship of war being sighted, it could be made known far and near, so that her escape would be rendered next to impossible, and her object would be frustrated."

Meteorology.—At the Royal Observatory, Greenwich, the mean height of the barometer in the week was 29·404 inches. The readings fell to 29·10 inches on Monday, and rose to 29·80 inches on Wednesday. The mean temperature of the air in the week was 40·1°, which is 0·1° above the mean temperature of the same week in 43 years (as determined by Mr. Glaisher). The temperature underwent a great and sudden change. The mean daily temperature was much below the average on the first four days; on Sunday, Monday, and Tuesday the extent of depression was 9° and 10°. On the last three days the heat was great for the season, and the excess above the average of mean temperature was from 8° to 13°. The lowest night temperature occurred on Tuesday, and was 22·5°. The highest day temperature occurred on Saturday, and was 60·5°. The range of the thermometer in the week was therefore no less than 38°. The mean daily range was 14·4°. The *minimum* temperature of Tuesday was lower than any temperature in March, since the 25th of that month in 1853. The difference between the mean dew-point temperature and air temperature was 6·6°. The mean degree of humidity was 81, complete saturation being represented by 100. The humidity increased from 72 on Tuesday and Wednesday to 97 on Thursday. The wind, which had generally blown from a northerly point in the early part of the week, changed to south-west on Tuesday afternoon, in which direction it continued with little variation till the end of the week. Rain fell on the last four days, and the whole amount was 0·26 in. The mean of the highest temperature of the water of the Thames was 41°; the mean of the lowest was 38·5°. A little snow fell in the forenoon of Monday. The night of Wednesday was very stormy, with heavy squalls of wind and rain. There was very vivid lightning on the evening of Saturday.

Operators on telegraphic lines frequently communicate with one another by touch, without a sounding magnet. No visitors are now permitted to stand in the vicinity of the sounding magnet in telegraph offices. —*Scientific American.*

The Wonders of the Wire.—Let our readers essay to follow the lightning-propelled messenger. Starting from the central office of the Electric and International Telegraph Company in London, it traverses our fertile eastern counties until it arrives on the banks of the German Ocean, into which it dives, and is flashed beneath its surging and tumultuous billows until it reaches the opposite shore, from whence it proceeds along its aerial metallic path to Amsterdam, then into Berlin, thence to Vienna, and with a gigantic stride over the Austrian and Turkish territories into the very heart of the sanctuary of the Osmanli, Constantinople—a direct distance of some 2,000 miles. Let us follow what took place, according to the information kindly furnished by Mr. Fleetwood Varley, between those distant towns, London and Constantinople, on the 7th ult.—early in the morning. Addressing the manipulator at the latter town, London wishes him "Good morning. I am most happy to speak with my countryman. I have still messages for you."—Pera replies and enquires, "Is Lord Palmerston still alive?" London immediately responds, "Yes, I am most happy to say, and quite well. How many messages have you? We are ready to take all." Pera.—"What is your name?" (London clerk gives his name.) Pera replies "You are a brick; my name is O'Connor; I have ten messages for you, and I now leave the instrument to a good Greek clerk, speak French to him; good night." London:—"Good night." The messages were then taken off direct from Pera (Constantinople) to London, at the rate of from 7 to 8 words per minute, and there were only two repetitions required in the ten messages. It should be here observed that all the foreign lines were linked together by relays and translators, so as to form one direct chain of communication between London and Constantinople. The importance and advantages of such an expeditious means of intercommunication to our social, commercial, and political requirements is so apparent, that comment would be superfluous.

Nitric Acid Batteries.—A correspondent suggests the use of sulphuric acid and powdered saltpetre, in lieu of the more costly nitric acid, for the Grove, Bunsen, and Maynooth batteries. The plan has been tried with very good results. The fluid is simply equivalent to a mixture of nitric acid and sulphate of potash.

To Correspondents.

H. T. writes: "I experience great difficulty in obtaining good sheet zinc at a moderate price. Ironmongers keep common stuff, very variable and uncertain in quality for galvanic purposes, and having no shearing machine are compelled to cut out plates by hand, which makes them very expensive. If some party in London having a proper shearing and drilling machine would undertake to supply plates of any size and uniform quality, and fair price, it would be a boon to students generally. Opticians *will* charge too much. The labour and cost of cutting out with a chisel 100 pieces must be considerably greater than if done by a common shearing machine, and to this expensive mode almost all provincial amateurs appear to be driven

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The Electrician.

Vol. I. No. 20.—March 21, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

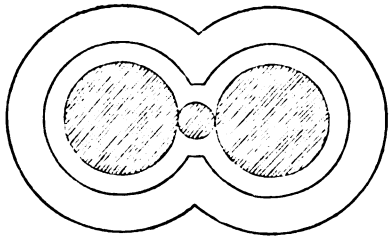
[Continued from p. 219.]

105. We have in our former pages demonstrated, both theoretically and practically—not that a given body insulated in the air can have the same charging capacity at all times, which has been hitherto taken as granted—but on the contrary, that its charging capacity varies with the circumstances of its surrounding inductive atmosphere, increasing and decreasing with the rate at which the electrical charge can have the intensity of its inductive action reduced, and thus an artificial equilibrium set up.

106. In order that we might keep our ideas as free from complication as possible, we have hitherto considered each case that has been adduced under only one given intensity; but now we must investigate the effect which a variation in intensity will have upon the charging capacity of a conductor; and we shall have to show that generally it is not the same under any two different intensities.

107. Perhaps the best way of showing the theory of this will be to refer to a former diagram (par. 86, printed by error, 80), in which three spheres are placed in consecutive contact (see fig. 8), and surrounded by an inductive atmosphere that could confer on the smaller and middle one either no charging capacity or only a very small one; and then to compare the diagram with the following modification of it, in which it has received a newly added outline interposed between the three conducting

Fig. 15.



surfaces on one side, and the boundary of the surrounding inductive atmosphere on the other. The new outline, it will be perceived, has been traced, as in former cases, at a distance equal in all places from the conducting surfaces upon which the air within it is conferring charged capacities, the only difference being that its distance is smaller than that of the outline it is supposed to supersede, that diminution denoting, of course, that the induction of the charge is expiring under a less amount of diffusion, and therefore, that the capacities of the conducting surfaces are less than they were represented under the unaltered figure. Now, by following the new outline with the eye we plainly perceive that there may be a narrow zone of inductive atmosphere around the small ball, having its surface nearer to it than to either of the larger ones. And from that circumstance we learn that at some small intensity the middle ball may have a minute electrical charge. In conformity to this result of our theory, we find in practice, if we use very low intensities in the manner described for experiment 16, that sufficient charge may be received by the middle ball to cause the gold leaves of the electrometer to diverge sensibly when that instrument has the charge transferred to it; and this will explain why, in speaking of the middle ball of the three, without specifying exact intensities, we have on one or two occasions said its charging capacity may be *either* nothing, or something inconsiderable. Surely this minute accordance between theory and fact is not the work of chance! but we have many such, which we shall adduce if our readers will follow us with their attention.

108. To proceed: take the extreme and opposite cases of a sphere supposed to be of infinitely small magnitude, represented by a point, and of a plane, which we may represent in section by a short line, as in the following diagrams.

Fig. 16.

Fig. 17.

In the above figures we have placed our theoretical pyramids upon both the point and the line, in order to depict their relative charging capacities under an unit of electrical intensity, each of the pyramids, shown in section, representing an unit of charge in possession. Let us suppose now that we are progressively increasing the intensity by additions to the quantity of electricity at the vertex of each pyramid on the line; it is obvious that as we do so the length of the pyramids must increase as the only way for their bases to become extended, as is required for the extinction of the growing intensity. And if the dimensions of the pyramids thus increase, the number of them that can find places on the line of limited length must proportionately diminish. If we go through the same theoretical process with the point, we shall find that the quantity of electricity at the vertex of each of its pyramids may be indefinitely increased, and consequently the intensity of the charge also, without any falling off in the number of the pyramids; because when assembled around a point they admit of any enlargement, while their length and their bases are always increasing in the same constant proportion to one another.

109. It is obvious, therefore, that the relative charging capacities of points and lines, considered as mathematical figures, would not theoretically bear the same proportion to one another under varied intensities; and there can be no difficulty in extending the same conclusion to a minute mechanical point when compared with a physical plane surface, supposed to be without perimeter.

110. After this it will be scarcely necessary to say that the charging capacities of spheres of unequal diameters will not bear a relation to one another that is uniform at different intensities; and if Coulomb had only discovered that to be a fact, as he might have done by a slight extension of his observations, he would have refrained from giving as a general ratio what was only an accidental one; he would have spared Poisson an arduous mathematical labour founded upon that ratio, and electricians at large the infliction of a theoretical incubus, that unfortunately has lived long enough to become venerable, and to prove as tenacious and unsatisfactory as the

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fabulous one that fixed upon the shoulders of Sinbad; let us hope this is soon to be got rid of.

111. Under our explanation of charging capacities it is easy to perceive that if a wire with a fine point, projecting from a large sphere, be insulated and charged with plus electricity progressively increasing in quantity, the two will absorb charge at very unequal rates; for while the charging capacity of the large convex surface increases very slowly under given increments of intensity, that of the point will increase with great rapidity.

112. It is hardly necessary to say that when we use pyramids having a constant relation of length to base to represent the relative charging capacities of one and the same conducting surface under different intensities, we need only to measure and compare the lengths of the pyramids in the several cases, taking a double length to denote a double quantity of charge, a treble length a treble charge, and so on; because it is quite clear that at double and treble distances from their vertices, the pyramids inclose each a quadruple, and a nine-fold quantity, respectively, of aërial matter for the induction to be distributed amongst; and double and treble quantities of charge having their induction distributed in those precise ratios exhibit an unaltered intensity. For example: suppose we had a charged surface containing two units of plus electricity propagating a certain intensity of induction to the bases of pyramids two units in length, and that we call the charging capacity $2\times2=4$; suppose further, that after adding to it more plus electricity we find the same intensity of induction propagated to the bases of the same pyramids when elongated to four units of length, and want to know what the quantity of the plus charge must have been to occasion it? The answer is, the original 2 units of quantity $\times4$ units of length$=8$, that is, the charge is double what it was before. If the pyramids be 3 units in length, or 5 units, then $2\times3=6$, or $2\times5=10$, will denote the charging capacities respectively.

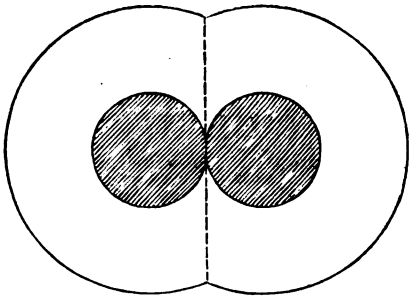
113. It is imagined that no one will make the mistake to suppose, that, because we figuratively represent the induction of units of electrical charge as being propagated from the vertices of pyramids, the electricity constituting the several units is all assembled at particular points on the surfaces of conductors; for a moment's consideration teaches us that, although each vortex may be regarded as indicating the place of the *centre* of an unit of charge, the electricity will distribute itself around that centre, in order that its induction may *set out* opposed by the lowest possible amount of reaction, all which was explained when we were commencing the subject of the charging capacities of spheres (78).

114. It is now very easy to understand that the intensity of a charge in an insulated conductor must suffer reduction by division with a second conductor, or by becoming in any way distributed over a larger extent of surface; for in either case the inductive action when it first sets out will be less on each particle of air, and consequently sooner become insensible under any given rate of distribution. This, however, we will practically show to be the case, as the experiment may serve to introduce a series to which we must now turn our attention.

Exp. 19. Into the inverted cup on the summit of the gold leaf electrometer, put a long brass chain, having one of its ends made fast to a silk thread passing through a ring fixed just above it to the ceiling. By means of an insulated ball (83) transfer to the chain from the conductor of a revolving machine a sufficient charge to cause a considerable divergence of the gold leaves in conducting communication with it; and then proceed to raise part of the chain by pulling the loose end of the silk thread; as the chain becomes freely exposed to a larger inductive atmosphere, the leaves of the electrometer will collapse, indicating that the charging capacity is thus being made greater, and consequently the intensity of the charge diminishing.

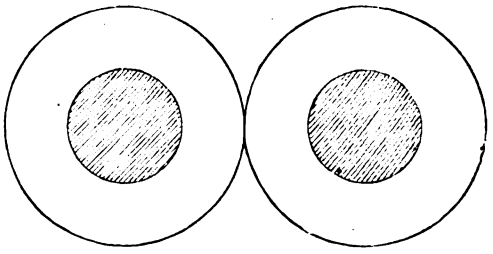
115. It matters not how this increased exposure of the charge to a surrounding inductive atmosphere is effected; it may be done in a variety of ways, some of which are very instructive. Let the following figure represent two of the insulated conducting

Fig. 18.



spheres (35) charged and placed in mutual contact; the two will then be surrounded by equal inductive atmospheres, neither of which, however, will be a perfect sphere, as would be the case if the conductors were placed far enough apart, as shown below, and charged during a temporary communication with one another.

Fig. 19.



116. By comparing the two last figures together, we perceive that the conductors with the perfect spheres of inductive atmosphere must have its bounding surface at a smaller distance than in the case of the imperfect inductive spheres; and therefore the charge in fig. 19 will be held under a lower intensity than in fig. 18; pyramids if introduced into it would be more numerous, and not so long. Now the difference of their length—that is, of the two intensities—represent a force by which fig. 18 tends to pass into fig. 19, or, in other words, *a force of attraction by which the conductors that are in contact tend to separate from one another.* If the balls be light and suspended by threads, the separation will take place; not unrestrainedly, but to some point short of what is due to the electrical force, and that will be determined by their gravity. If, on the contrary, the balls be heavy in proportion to the reduction in the attraction that is to be achieved, the separation may be more limited, or in extreme cases, altogether absent, as much so as though the conductors were locked to one another by visible artifices.

117. Here then is a clue to what has been called electrical repulsion, tracing the separation of bodies when similarly charged to the force of electrical attraction, as we have before done the dispersion of the electrical charges over the surfaces of conductors, a phenomenon which until then had been equally attributed to a force of repulsion.

118. The theory will lead us with great minuteness into the hitherto sealed mysteries of electrical repulsions, and we shall be ready to follow it into these particulars as opportunities arrive for doing so. We have, however, one other observation that may here be conveniently made respecting it, because it may be illustrated by the diagrams now before us; it is this: the phenomena known as electrical repulsions exhibit in an unquestionable manner this fact—as the intensities of charge in the two balls, fig. 18 increase, so does the force with which they tend to assume the relative positions of the two balls in fig. 19; and we know enough of the causation to perceive that as the intensities increase, and with them the distance of the boundary line of the inductive

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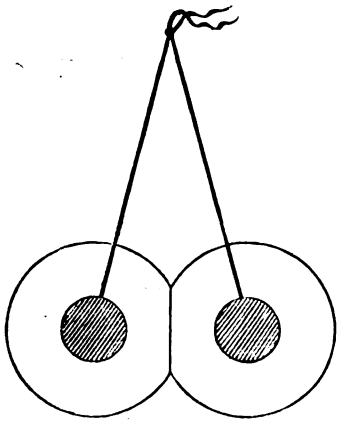
atmosphere, so also will the segments wanting to complete the aërial spheres in fig. 18, and therefore also the difference in the intensities by which fig. 18 tends to pass into fig. 19.

119. If we put suspending threads to the balls in the last figure, as below, the electrician will not need to be informed that

Fig. 20.



by aid of our diagrams we have been tracing the theory of the common electrometer of Canton, a well-known and very useful instrument made by passing cotton threads through a pair of small balls made of cork, or the pith of elder, and so uniting them that the balls may hang a few inches below their point of suspension, and be in mutual contact. When insulated and charged, they are attracted in opposite directions by the surrounding atmosphere, and under that force separate from one another. The action of the gold-leaf electrometer is exactly the same; and when we apply to it the same theoretical explanation, the only distinction we have to make between them is to assign to the leaves when diverging a corresponding form of inductive atmosphere.

(To be continued.)

THE INVENTION OF THE ELECTRIC TELEGRAPH.

Whether rightly or wrongly, Professor Wheatstone appears to have the credit of having introduced and perfected the electric telegraph in this country. We arrive at this conclusion from the perusal of an article quoted from the *Times* in another portion of our columns, and from an article entitled "Long Sea Telegraphs," which has recently appeared in *All the Year Round*. Thus in the *Times* article we note the following:—"In the quarter of a century which has elapsed since Professor Wheatstone first set up his apparatus and passed his signals through five miles of wire, more ought to have been done to unite the mighty and far divided fragments of our great empire." And in *All the Year Round*:—"Professor Wheatstone, to whom the world is more indebted for the perfection to which land telegraphs have been brought than to any man living, suggested submarine telegraphs so early as 1837."

It is but seldom we have occasion to criticise contemporaneous journalism, and we have no particular desire to endeavour to overthrow received facts unless we can show that others, which are more in accordance with truth and with verified records, should be substituted for them. Still less have we any desire to assert anything derogatory to the deservedly recognized scientific reputation of Professor Wheatstone. But we, and doubtless many of our readers, have been under the impression that the claims of William Fothergill Cooke in regard to the introduction and perfection of our present system of telegraphy, deserve prior recognition to those of any other man, whether merely "practical" or acknowledged in the scientific world. In regard to the paragraphs we have quoted, we feel bound to observe that although we have ample evidence, that so early as June, 1837, Mr. Cooke erected several miles of wire in his experiments on the London and Birmingham Railway, we have no record that "a quarter of a century ago" Professor Wheatstone transmitted electric signals through five miles of wire; although the Professor may certainly have done so in his capacity of partner with Mr. Cooke, in an application originated and practically carried out by the latter gentleman. More than six months before the above date, and previously to his partnership with Professor Wheatstone, Mr. Cooke had endeavoured to introduce the electric telegraph for the purpose of signalling through a tunnel upon the Liverpool and Manchester Railway. The instruments and system of Mr. Cooke had at that time received the encouraging approval of Professor Faraday, and were put forward in a practical form; while all that had been done by Professor Wheatstone towards the practical development of the electric telegraph was confined to the "permutating principle" of his key-boards. Moreover, after carefully considering what was subsequently done by both gentlemen in partnership to perfect the electric telegraph, we are bound to assert that to Mr. Fothergill Cooke the world is most indebted for the perfection to which land telegraphs have been brought, and to register our protest against his claims being ignored either by public journalism or by scientific bodies.

We have published on several occasions historical facts in connection with the electric telegraph, and amongst these will be found the award of the arbitrators mutually appointed to decide the question of the relative position of William Fothergill Cooke and Professor Wheatstone with regard to the invention of the electric telegraph. We need therefore scarcely remind our readers that this award, the justice of which was acknowledged, not only by the parties principally concerned, but by the scientific and telegraphic world, was as follows:—

"Whilst Mr. Cooke is entitled to stand alone as the gentleman to whom this country is indebted for having practically introduced and carried out the electric telegraph as a useful undertaking promising to be a work of national importance; and Professor Wheatstone is acknowledged as the scientific man whose profound and successful researches have already prepared the public to receive it as a project capable of practical application; it is to the united labours of two gentlemen, so well qualified for mutual assistance, that we must attribute the rapid progress which this important invention has made during the five years since they have been associated.—Mc. I. Brunel, J. F. Daniell, *London, 27th April*, 1841."

"*London, 27th April*, 1841. Gentlemen,—We cordially acknowledge the correctness of the facts stated in the above document, and beg to express our grateful sense of the very friendly and gratifying manner in which you have recorded your opinion of our joint labours, and of the value of our invention.—We are, gentlemen, with feelings of the highest esteem, your obedient servants, Wm. F. Cooke, C. Wheatstone. *Sir M. Isambard Brunel, and J. F. Daniell, Esq., Professor, &c., &c.*"

We forbear to comment upon the general inaccuracy of the article which appeared in *All the Year Round;* it being sufficient that we should have called attention to a statement which involves a serious injustice. In telegraphic annals the names of Soemmerring and of Schilling will be quoted when the question is mooted of the first idea of electric signalling, and those of Cooke and of Wheatstone, in the relative order we have given, when the practical introduction of the electric telegraph is referred to.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 222.]

*Let us now consider the inductive resistance between cylindrical surfaces placed concentrically one within the other, and each attached to one pole of a source, so that direct induction takes place between them. Then their annular ends will be exposed to any outer opposing surface which bounds the whole arrangement, and an indirect inductive circuit will be formed which will

* I had intended placing the following problem, relating to cylindrical resistances, at a different part of the essay, but have since found it advisable to introduce it here, in order to render the part relating to the laws of accumulation more complete.

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not follow the same laws as the direct inductive circuit between the cylindrical surfaces.

If the two cylinders are each terminated by flat or hemispherical surfaces, then all the inductive action will take place between the two complete surfaces thus formed; but if the dimensions of one of these cylinders are altered in the same ratio in every direction, the alteration in the inductive resistance between the flat or hemispherical ends will not increase or decrease in the same proportion as that between the cylindrical surfaces.

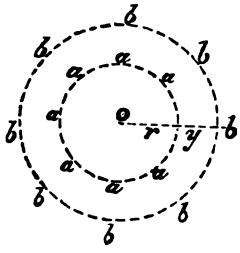
We may suppose, however, the cylinders so long that the proportionate effect of the ends may be neglected altogether, and thus suppose the inductive action to go on entirely between the two cylindrical surfaces.

In such case the resistance of the inductive circuit is composed of a hollow cylinder of dielectric. Let us consider the resistance of different layers of such a cylinder, and for this purpose let us consider first the resistance of an indefinitely thin layer of the dielectric immediately surrounding the interior conducting surface; then following the same reasoning as in the case of spherical shells, we may treat this layer as a flat sheet of the same surface as the surface of the interior conducting surface. Considered as a resistance in the direction of its thickness; this sheet will have for *length* its thickness, and for *sectional area* its surface.

If now we compare the resistance of different indefinitely but equally thin layers composing a thick hollow cylinder of dielectric of a given length; then as their thickness is the same their proportionate resistance will be inversely proportional to their sectional areas, but these will be proportional to their radius multiplied by the *length of the cylinders*. The length of the cylinders is constant to all, and their resistance is therefore inversely as their radius.

If r equals the radius of a layer a
y the distance between a and another layer b, exterior to a.
p the resistance of a
x the resistance of b.

Fig. 34.



Then $r + y : r :: p : x$

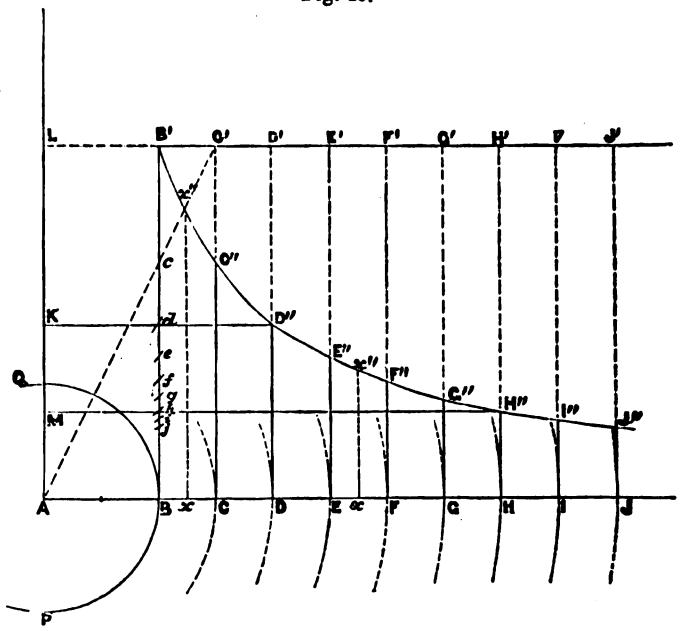
or $x = \frac{rp}{r+y}$

The greater r is compared to y, therefore the less will be the difference between p and x, or resistance of a and b. If a is the interior layer of all the next layer to it will therefore approach more nearly to its resistance than any other layer, and therefore the resistance of each successive layer decreases outwards.

If y represent the distance between any two consecutive layers then of any two pairs of consecutive layers, those will approach the more nearly to equality which have r the greatest, or which are, in fact, the more remote from o.

*Let AB (Fig. 48) represent the radius of a cylindrical conductor of a given length x and a portion of the section of which is represented by B P Q, and let B C, B D, B E, &c., equal the distances between B P Q and different exterior cylindrical opposing surfaces. Then the resistances of the inductive circuit will, in the several cases, consist of hollow cylinders of a length equal to

Fig. 48.



x, and whose inner radii are always A B, and whose thicknesses are B C, B D, B E, &c.; which resistances we wish to compare.

Draw BB′ perpendicular to AB, and let BB′ represent the resistance of an indefinitely thin layer of dielectric immediately surrounding B P Q, and whose thickness we call t, and radius A B.

Then the resistance of any other layer, of t thickness, whose radius is A C, will be to that having a radius A B, directly as their thickness, and inversely as their radii; but their thickness being the same, simply inversely as their radii. The resistance of the layer at C will, therefore, be to that at B as A B is to A C.

But since B B′ represents the resistance of the layer at B, then to express resistance of the layer at C in terms of B B′, we have, calling resistance of C, o, or ordinate

A C : A B : : B B′ : o (=C C″); or

$$o = \frac{\text{A B . B B}'}{\text{A C}}$$

To obtain the ordinate o geometrically for the points C, D, E, F, G, &c., draw C C′, D D′, E E′, &c., parallel and equal to B B′, and from C′ draw C A′, cutting B B′ in c. On C C′, cut off C C″ = B c. Then

A C : A B : : C C′ : B c;

but B c = C C″; therefore,

A C : A B : : C C′ : C C″.

C C″ therefore represents, in terms of B B′, the resistance of a layer of t thickness having a radius A C.

In the same way D D″, E E″, &c., may be obtained*, each representing the resistance of the indefinitely thin cylindrical layers whose radii are respectively A D, A E, &c.; and if we take a sufficient number of abscisses and ordinates, a curve, B′ C″ D″ E″, &c, may be traced, whose ordinate xx'', taken at any intermediate point x, will give the resistance of any indefinitely thin cylindrical layer whose radius is the abscis A x.

Now the resistance of any hollow cylinder of a thickness B C, is made up of the resistance of all the successive indefinitely thin layers of which B C is composed, and the resistance of any one of these layers is expressed by the ordinate of the curve B′ C″ D″ E, taken with the radius of such layer as abscis.

* In the above and following pages it will be seen that the problem of the proportionate resistances of concentric cylindrical layers of dielectric is not merely illustrated, but *solved*, purely by plane geometry, whilst it agrees with the formula arrived at by Professor Thomson (and also by Mr. Longridge), by the differential calculus. It may be useful, therefore, not only as an illustration of the formula $R = \text{Log.} \frac{D}{d}$ but as an example of what may be done in similar electrical questions by plane geometry.

* The lines D′ A, E′ A, F′ A, &c., are omitted in the figure in order to avoid confusion their intersection with B B′ being shown.

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If we take t as the thickness of the thin layers composing any cylinder B C, and represent their resistance by their ordinate multiplied by t, instead of by their ordinate only, they will still retain the same ratio to one another, and be represented by an area instead of a line.

But the resistance of the cylinder B C being composed of the sum of the resistances of all the layers composing it, will be represented by all the t's contained in the distance B C, each multiplied by its ordinate; but this will give approximately the figure B B′ C″ C; and as we may take t as thin as we like, if it be supposed infinitely thin, it will give the area of B B′ C″ C exactly. The same may be proved of any other cylinder whose thickness is C D, or D E, or of any which is the sum of these two, or C E.

The resistance of cylinders whose inner radii equals A B, and outer radii A C, A D, A E, &c., will be, therefore, as the spaces A B′ C″ C, A B′ D″ D, A B′ E″ E, &c., respectively.

Now from A draw A L at right angles to A J, and take A K = D D″, and A M = H H″;

then, A B : A D : B d : D D′;

but B d=D D″, and D D′=B B′.

therefore, A B : A D : : D D″ : B B′;

or, $$B\,B' = \frac{A\,D \,.\, D\,D''}{A\,B};$$

and, A B : A H : : B h : H H′;

but B h=H H″, and H H′=B B′,

therefore, A B : A H : : H H″ B B′;

or, $$B\,B' = \frac{A\,H \,.\, H\,H''}{A\,B.}$$

Therefore, A D . D D″ = A H . H H″;

or the parallelograms A K D″ D and A M H″ H are equal; and the same may be proved of every parallelogram two sides of which fall on A L and A J, and whose opposite angular point to A is situated on the curve B′ C″ D″, &c.

But this is one of the properties of the hyperbola and its asymptotes; and the curve B′ C″ D″, &c., is therefore an hyperbola, and A L and A J are its asymptotes.

But the spaces B B′ D″D, B B′ F″ F, &c., (representing the proportionate resistance of cylinders having an inner radius A B, and thickness B C, B D, &c.,) are, by the properties of the hyperbola, proportional to the logarithms of A D, A F, &c., when A B is taken as unity, or, in fact, to the logarithms of $\frac{A\,D}{A\,B}, \frac{A\,F}{A\,B}$ &c., or the logarithms of the ratios existing between the radius of the inner and outer cylindrical surfaces of the several cylindrical resistances B D, B F, &c.

In the figure given above, as the asymptotes A J and A L are at right angles, the spaces B B′ D″ D, B B′ F″ F, &c., will bear the same ratio to the area of the rectangle A L B′ B (or unity of area *), as the Napierian Logarithms of the numbers 2, 3, &c., bear to unity.

If the asymptotes (and the lines parallel to each) form some other angle with one another than 90°, the *absolute* area of all the spaces B B′ D′ D, &c., will be altered as the sine of the angle is altered.

Thus if the angle of inclination be 25° . 44′, the value of all the spaces B B′ D″ D, B B′ G″ G, &c., will be altered as 1 . (or sine of 90°) is to ·43418 (or sine of 25° 44′).

All the spaces B B′ D″ D, &c., will now bear the same ratio to the *same unit of area* (viz., *the rectangle* A L B′ B), as the Napierian Logarithms of 2, 3, 4, &c., multiplied by ·4318 (or, in fact, the common logarithms of 2, 3, 4, &c.,) bear to unity.

This alteration of the angle does not alter, therefore, the ratio of the spaces to one another (since they are altered in the same proportion), and as it is only their ratio to one another which represents the ratio between the resistances of the different cylinders of dielectric, these resistances are, therefore, either as the Napierian, *or* common logarithms of their outer radius, their inner radius being the same and taken as unity.

Thus, if A B = 1, A D = 2, A F = 3, A H = 4, &c., then the resistances of the cylinders whose thicknesses are B D, B F, B H, will be respectively as the common logarithms of 2, 3, 4, 5, &c.; or as 0·3010, 0·4771, 0·6020, 0·6989, &c.

If we take cylinders whose inner radii, as well as their outer radii, are different, then it can be easily shown that the resistances of such cylinders will be to one another also as the logarithms of the ratio between their inner and outer radii.

For suppose any two cylinders of different interior radius, the one having an inner radius A B, and outer radius A D, and any other having an inner radius A D, and outer radius A H. Then, as has already been shown, the resistances of these cylinders will be to one another respectively as the spaces B B′ D″ D and D D″ H″ H.

But if A B be taken as unity, the space B B′ B″ D : the rectangle A L B′ B : : log. $\frac{A\,D}{A\,B}$: unity.

And if A D be taken as unity, the space D D″ H″ H : the rectangle A K D″ D : : log. $\frac{A\,H}{A\,D}$: unity.

But the rectangles A L B′ B and A K D″ D are equal; calling either x, we have B B′ B″ D : x as log. $\frac{A\,D}{A\,B}$: 1.

and D D″ H″ H : x as log. $\frac{A\,H}{A\,D}$: 1.

Therefore, B B′ B″ D : D D″ H″ H as log. $\frac{A\,D}{A\,B}$: log. $\frac{A\,H}{A\,D}$

But B B′ B′ D and D D″ H″ represent the proportionate resistance of cylinders whose interior radii are respectively A B and A D, and exterior radii A D and A H; and their resistances are therefore to one another as the logarithms of the ratios between their exterior and interior radii; and the same may be proved of the resistance of cylinders (of equal length and of the same distance), which are therefore to one another as the common, or Napierian logarithms of the ratio between their interior and exterior radii or diameters.

If the length of any cylinder is increased without altering the radii of their inner and outer surface, then as the sectional area of each layer composing the total resistance is decreased exactly as the length is increased, the inductive resistance will be decreased in the same proportion, and consequently the quantity that can be accumulated with a given source will be increased in the same proportion; but as the surfaces on which this quantity is disposed is also increased in exactly the same proportion as the length is increased, the density will remain unaltered.

By the same reasoning as that applied to spherical shells, if D D″ be the resistance of a thin layer round a cylinder whose radius is A D, then we may suppose the outer cylindrical surface opposing the inner cylinder so far distant, that when we decrease A D to A B, and thus halve the surface of the inner cylinder, we shall not double the inductive resistance, and consequently *not* halve the quantity; but this will be now disposed on half the surface, and the density will therefore rise.

(To be continued.)

* That A L B′ B is what may be termed the unity of area, would be more easily seen if B B′ be taken equal to A B, when the rectangle A B B L = A B² or (A B being = 1) 1² or 1. But it can be easily demonstrated that if B B′ be taken unequal to A B, then the unity of space is represented A B, B B′.

THE INDUCTION COIL.

It will greatly facilitate, in a practical point of view, our consideration of the induction coil to regard it merely as a magneto-electric machine in which an electro-magnet is employed in lieu of a horse shoe of soft iron influenced inductively by a permanent magnet. It is true that the conclusions based upon this view should be submitted to some revision, and compared with those we arrive at by studying the effects which are due to dynamic induction; but, as it is evident that the

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effects of the coil are mainly due to magneto-induction, and we cannot therefore be far wrong in endeavouring to perfect this condition.

This view enables us at once to adopt a principle in the construction of the coil, and to determine satisfactorily certain points which might otherwise remain obscure. Thus, with regard to the length and diameter of the wire in the primary circuit, it becomes obvious that the primary coil should be sufficient to enable us to magnetise the soft iron core as nearly as possible to saturation, and that, with a given core of soft iron, no advantage, but rather the contrary, is obtained by increasing the length or the diameter of the wire beyond a certain limit. In neither case can we obtain any greater magneto-electric effect, and the augmentation of the primary coil necessarily increases the distance of the secondary wire from the centre of magnetic action. The first thing to be obtained in constructing a coil machine is a powerful electro-magnet. To this effect we must of course bear in mind the importance of substituting a number of soft iron wires for a solid core of the metal. A progressive increase of power in very rapid ratio is obtained by augmenting the diameter of the core, providing there be no limit as to the amount of battery power which may be employed. With a *given* battery power, the magnetic intensity developed in iron cores is proportionate to the square roots of their diameters; and the *maximum* of magnetization which it is possible to produce is proportionate to the square of the diameters.

Electro-magnets of equal power may be obtained with a short length of stout wire, or with a greater length of fine wire. For the induction coil a "quantity magnet"—that coiled with stout wire—appears in every respect to be preferable to one coiled with fine wire. With the latter a current of considerable tension would of course be required; and the amount of electricity traversing the primary circuit would practically be much less than in the case of the coil of stout wire. We may observe that the effect of voltaic induction, considered separately from that of magneto-induction, appears to be dependent in a greater degree upon the quantity of electricity traversing the primary wire than upon the tension of this current; although in regard to voltaic induction this property is undoubtedly active.

It is desirable that the experimentalist should employ a quantity galvanometer, placed in the primary circuit, to determine once for all the amount of battery power requisite to obtain a sufficient degree of magnetization in the soft iron core. By this means he may obtain valuable practical knowledge of the properties of the electro-magnet and of the voltaic battery; and by using the same galvanometer he may at all times ascertain, on the one hand that the voltaic power is sufficient for the purpose in view, and on the other hand that a surplus of power is not wastefully employed. Beginning with a current of low tension, the amount of battery surface should be increased until the iron core is magnetised to saturation, and the deflection on the galvanometer may then be noted. When the secondary wire has been been coiled, the experimentalist may then study the effect of increased tension in the current produced by connecting together by their opposite poles several similar battery arrangements to that employed for the quantity current. The increased tension will be inactive in regard to the magneto effect, and only indicated upon the galvanometer in circuit by a slight increase in the deflection, due to the greater quantity of electrcity passing at this tension. Any increase in the effects of the coil machine will therefore be due solely to an increase in the dynamic inductive action.

The advantage of using several distinct coils, instead of one continuous length, for the primary wire is that it enables us to employ a current of very low tension, provided it be of considerable quantity—such as that from the Callan or the Maynooth couples, in magnetizing the iron core. Here again, however, it is necessary to consider whether in perfecting the coil as a magneto-electric machine, we do not interfere with the dynamic inductive action, which in large and powerful coils is undoubtedly active in increasing the tension effects. The conversion of electricity of very low tension into electricity of high tension is a problem of sufficient importance to render it desirable that a series of comparative observations should be made with induction coils of various constructions. At the present moment, however wonderful may be the results which already have been obtained, we have very little experience to guide us in constructing the coil machine, which may almost be considered in the light of a new and unperfected philosophical instrument.

As in the ordinary magneto-electrical machine, we may obtain in the induction coil an induced current of considerable quantity and low tension from a coil of stout wire; while for currents of tension it is necessary greatly to increase the length of wire under induction. It appears obvious that if it were possible to develop electricity of high tension at the extremity of a wire offering but little resistance, the tensions would become neutralized through the metallic conductor, rather than through a short space in atmospheric air, offering comparatively great resistance to the passage of electricity. Indeed, to account for the inductive discharge in air, it is necessary to take into consideration not only the instantaneous liberation and high tension of the electricities at the opposite terminals of the secondary wire, but also the great amount of resistance in the return circuit. As might be expected, we find that in *vacuo* the effect of the inductive discharge is greatly increased. It may be suggested therefore that as the resistance in the medium portion of the secondary wire is an important element in regard to the effects of the coil, this resistance might advantageously be increased by such means as the insertion of a length of fine iron wire between the two portions of wire assuming opposite tensions. Moreover, it appears probable that by *breaking* the secondary circuit at this middle portion of the length of wire, at the same moment as the primary circuit is broken, the effects of the coil and of the magneto machine, whether in regard to currents of quantity of currents or of tension, might be greatly increased. We offer these hints for the advantage of those who have particularly directed their attention to the induction coil, and in whose hands this new and powerful instrument may become developed and improved,

RANDOM PAPERS BY A PRACTICAL MAN.

II.—Soldering Joints.

It was remarked at the conclusion of the first of these random effusions, that no permanent joint should ever be allowed to exist in a telegraphic circuit without its perfect continuity being insured and maintained by careful and complete soldering. I can recollect the existence of a fault in one of the circuits under my charge which for many weeks baffled my exertions to detect its position. It was what is technically termed an "*intermittent* fault." It would occasionally, for a minute or two, completely disconnect the circuit. It would sometimes produce so much resistance as to materially reduce the currents, and perplex the operators. It never lasted sufficiently long to allow me to test for its locality. After satisfying myself that it was not in any office, I concluded that it must be a bad joint on the line. I had every visible joint carefully examined and resoldered, without success. At last I attacked the invisible portions of the circuit, and eventually found it at the mouth of a tunnel. Some stupid careless fellow had omitted to solder a joint in the gutta percha *wire*. It became loose by the expansion and contraction of the heat, and partially oxidised through its being imperfectly cleaned. The passing trains affected it. Want of continuity or sometimes resistance was the result. Thus, much valuable time was employed, and expense incurred, in remedying the omission of a careless workman. No experienced telegraphist will entrust the making of a joint to any but the most reliable hands.

Soldering is a term applied solely to the process of uniting the surfaces of metals. It is done by the intervention of a more fusible metal than that which has to be united. The soldering metal, being melted upon each surface, serves partially by chemical affinity, and partially by the exertion of cohesive force, to bind them indissolubly together.

Solder is usually an alloy. It must not only be more fusible than the metal or metals to be joined, but it must have some chemical affinity for them. Hence different sorts of solder are employed for different purposes. It is called either hard or soft, according as its fusing point is high or low. Thus there are—

1. Hard pewterer's ..... 2 bismuth; 4 lead; 3 tin
2. Soft do. ..... 1 do.; 1 do.; 2 do.
3. Hard plumber's ..... 1 do.; 2 do.
4. Soft do. ..... 3 do.; 1 do.
5. Hard spelter..... 12 zinc; 16 copper
6. Soft do. ..... equal parts zinc and copper.

Hard spelter is used for copper and iron purposes, and soft spelter for brasswork. There are also particular solders used for gold and silver work.

Now, before two surfaces can be joined together, they must be made perfectly clean, and freed from oxide, or other foreign substance. This was formerly effected by spirits of salts (hydrochloric acid); but this process has been completely abandoned in joining copper wires, owing to the energetic action of the acid upon the metal, and the danger of leaving some on to corrrode the wire and endanger the joint—a fact of frequent occurrence. This salt is still much used for iron wire, but chloride of zinc is far superior, and less dangerous, and should be universally used. It is easily made by saturating spirits of salts with pure zinc. The surfaces of copper wire are cleaned by

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scraping or filing, and to prevent the formation of oxide the cleaned surfaces are coated with a flux, such as borax, sal ammoniac, resin, Venice turpentine &c.

Borax is perhaps the best flux because, in addition to maintaining the cleanness of the surface of the metal, it dissolves any oxide that may form there, on the application of heat; but resin is more frequently employed because it is more easily applied. Borax has to be reduced to a powder and then made into a paste with water, with which the metal is smeared. Resin can be powdered and applied dry.

There are many ways of applying heat to maintain the solder in a fusible state while in contact with the two surfaces, but soldering-irons and the blowpipe are usually employed in practice.

Soldering irons, or tools tipped with copper, are always tinned before being used, to render them neutral to the solder. They are heated either in a spirit lamp or small furnace, until they have acquired the proper temperature to fuse the alloy.

Iron wires are joined into certain lengths in the manufacturers shops, by a process called *welding*—the result of a property which iron possesses, of uniting intimately under the hammer, when heated to whiteness; but welds are very frequently carelessly effected and much trouble is frequently occasioned by their offering less strength than the wire itself. Hence they break on the application of strains either in the process of erection, or from contraction on the occurrence of cold weather. A good joint should be the strongest part of the wire.

There is a process of soldering called *acetagenous soldering*, the invention of a Frenchman, M. De Richemont, and it consists in the unison of two pieces of metal by fusing them together with a hydrogen blowpipe, but it is not used in any telegraphic process.

There is no difficulty in soldering wrought and malleable iron, but it is almost impossible to effect the same object with cast iron. Indeed, the attempt has been abandoned and small wrought iron plugs are tapped into pieces of cast iron for such purposes. Its crystalline structure seems to be opposed to the cohesive force necessary to obtain perfect juncture.

I will resume this subject in my next.

ATLANTIC TELEGRAPH COMPANY.

Report of the Directors to the Ordinary Annual Meeting of the Shareholders, held at the Offices of the Company, 22, Old Broad Street, in the City of London, on Wednesday, March 19th, 1862.

The directors herewith present to the shareholders the balance sheet for the year ending 1861.

They have to report that since they last met the shareholders, attempts have been made at Valentia to recover for sale some portion of the old cable. These efforts have not been successful to any remunerative extent, owing to the excessively bad weather on the west coast of Ireland during the whole period of the expedition.

The directors have been unceasing in their efforts to hasten the period, which they have ever felt must come, for the resuscitation of the great enterprize under their charge, by endeavouring to disseminate in proper quarters such information on the subject of cables as is calculated to restore confidemce in these unjustly neglected undertakings. In these efforts they have been most heartily and energetically aided by Mr. Cyrus W. Field. The American Government feeling during late events the want of this means of communication, have very recently addressed a despatch to their minister in this country, offering in a very handsome manner to co-operate with the British Government in adopting such measures as may be necessary for carrying into execution the telegraph between Newfoundland and Ireland, and for rendering it inviolate when complete even in time of war.

The directors still feel hopeful that this undertaking, notwithstanding its past troubles, will eventually weather them all and become a permanent and profitable enterprize. The great improvements that have taken place in every department of cable making since 1857, and the great comparative facility with which they can now be submerged, make it clear that in proper hands the laying of a cable between Ireland and Newfoundland, such as can now be produced, admits of no reasonable doubt. Depth of water has now been ascertained to be unimportant to the laying of an efficient cable: one is now in successful working order between Europe and Africa in not less than 1,890 fathoms.

The directors are assured on the highest authority that a suitable cable can be worked between Ireland and Newfoundland at the rate of eight words at least per minute; and they have abundant evidence that the route of which this company enjoys the privilege is the only one that is in any respect fairly practicable.

Mr. George Peabody, Mr. Francis Le Breton, and Mr. J. W. Brett were the retiring directors last year, but a quorum of shareholders was not present at the annual meeting; consequently the retiring directors were continued for the past year in conformity with the Company's Clauses Act. They now offer themselves for re-election by the shareholders in the ordinary manner.

The honorary directors retiring by rotation are—The Hon. E. M. Archibald, Mr. Peter Cooper, Mr. Wilson, Mr. G. Hunt and Mr. P. Corbin. The latter gentleman has not offered himself for re-election and it is proposed to elect in his place Mr. Cyrus W. Field.

It is also proposed to add to the list of honorary directors the names of Mr. W. E. Dodge of the firm of Phelps, Dodge and company, New York; and of Mr. Thomas C. Kinnear, of Nova Scotia; both of whom will be proposed for election.

By Order, GEO. SAWARD,
Secretary.

THE RED SEA TELEGRAPH.

The reader may remark that we to-day publish news from Bombay to the 27th of February—fifteen days ago! Steam and electricity have advanced thus far. Steam seems now a lagging, loitering messenger, taking fourteen days to cross the Indian Ocean and thread the perils of the Red Sea; the domestic lightning is the only servant whose speed is equal to the demands of our impatience. It is a comfort that we are hurrying on now to an achievement which must be final. When we have perfected the electric telegraph, we shall have at our service the only human discovery of which it can be said that it never can be exceeded and never can become obsolete. When we have outstripped the sun and annihilated space, we may fold our hands and let our labours bring forth their increase. If "the sovereignty of man lieth hid in knowledge," the telegraph is the distributor of that sovereignty equally among all mankind. Priority of information is power and wealth; it is the means by which active men and shrewd men get the better of slow, old-fashioned folk. The merchants of the East have never ceased to deplore those good old times when they got their advices twice a year, and when their customers in the West had no impertinent curiosity about markets and exchanges. In those days they had their intelligence, and could hoard it and make fortunes by it. All this is fleeting away from us. Already the disconsolate subaltern who sips his Mocha coffee at Aden, and thinks how fine its flavour might be if it were not necessarily made with salt water, is hardly behind ourselves in his knowledge of the passing events in London; and already we know almost as much as he does of the news of the East. We have had messages from the shore of the Red Sea delivered in London in twelve hours. While we write the notice arrives that the station at Jubal Island is open, and in a few weeks we shall be able to hold conversations with our friends beyond the Straits of Babelmandeb.

At this moment these things startle us, because they are exceptional; but it soon must happen that the knowledge of all contemporaneous events happening upon the globe will be accepted as one of the common necessities of a man of business. The merchant's sagacity will not be taxed to guess what may be the state of the markets in India, China, Australia, or America. These will all lie before him printed fairly on our broad sheet. He may employ his sagacity upon the future, but there will be no uncertainty in the past or in the present. Nations will not wait in trembling suspense to know how special items of intelligence may be received; nor shall we have Governments, in ignorance of what may be taking place on the other side of the world, prudently preparing for the worst. Human bodies may be separated by the thickness of the globe, but human minds will maintain their communion undisturbed by space. It will be a great revolution when it comes thoroughly into work. Many old vested interests will go down, and many new interests will grow up; and perhaps, after all, it may quiet rather than increase the struggles of mankind. It will take away many inequalities, destroy many misapprehensions which are causes of quarrel, and reduce to nothing the perpetual battle for early facts. What most strikes us, however, now that the new age is opening upon us is, that we should have allowed its portals to stand so long ajar. It is sixteen years since the murderer Tawell was arrested by the agency of the electric telegraph on the Great Western Railway. We have been all that time in full possession of the power which science had put in our hands, and we have been in full view of the great effects which must follow from its complete development. Yet we have either faltered or blundered in our way. We made an attempt to join the Old and New World, and we did it so clumsily that our success was our reproach. The electric band which faltered out its few faint words and relapsed into perpetual silence told us that it was we who were in fault, in that we had not observed the common vulgar conditions under which the science is made to work as an art. Since then we have made another great failure in the Red Sea, and, as this was attended with a smarting sensation of pecuniary loss, we have actually paused over the insignificant sacrifices necessary to push on the great and easy work. In the meantime we nearly went to war with America, because we had not a telegraph across the Atlantic; and we lost great part of our opportunity of stimulating the

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industry of India, because we had not a telegraph down the Red Sea and round the Arabian coast. We are now without the opportunity of directing our own policy in China, in the very possible occurrence of serious derangements, because we have no cable to Hong Kong. In the quarter of a century which has elapsed since Professor Wheatstone first set up his apparatus and passed his signals through five miles of wire, more ought to have been done to unite the mighty and far divided fragments of our great empire.

There is hope, however, that now this part of the work has been done. While we have been hesitating or blundering, other nations have been pushing ahead. The North of Africa has long since been covered with networks of wires, and the solitudes of Russia are traversed by the lines. The demand created by the formation of 150,000 miles of telegraphic wires has produced an increase of scientific knowledge and artistic skill. We have gathered experience as to the conditions under which an electric cable will endure and work under the sea; in what degree of shallowness it rusts, at what great depths the risk of breaking becomes imminent, and at what great lengths the resistance in working becomes a serious evil. With this experience we have already stolen along from London to Malta, from Malta to Alexandria, and from Alexandria to Suez. At this moment we are stealing down the Red Sea, preparing as we go, and, as the intelligence we publish in another column tells us, we are within a few weeks of an instant communication with Aden. This is on the very point of accomplishment. The rest is a promise. With the great Atlantic failure before them, our engineers no longer venture unnecessarily on deep seas. Instead of going under the Indian Ocean, they coast round the eastern shore of Arabia, and cross the mouth of the Persian Gulf to the shores of Beloochistan, whence a short circuit will bring them to the end of their labours by a junction with the Indian railways at Kurrachee. When this is done the East and the West will be united, and the state of India on every yesterday will be known in England every morning. There seems to be no very wild risk in the work now to be done, no long deep sea traverses, and no tremendous distances without a break. Much of the line is, more or less imperfectly, laid already, and we can see no real reason why Kurrachee should not be reached in a few months, as the engineers of the new company promise. It ought to have been done long ago. If other nations can lay 150,000 miles of wire, we, with such greater necessities, and so much larger interests at stake, ought not to have been among the last in such a race as this. However, the work will be done now, for out of the crowd of competitors in a new trade the men who know how to do it seem to be beginning to distinguish themselves.—*From the Times, 14th March.*

OCEAN TELEGRAPHY.—TELEGRAPHIC COMMUNICATION.

On Friday, March 14, a lecture was delivered at the Mechanics' Institute, Plymouth, by J. E. Davis, Esq., R.N., F.R.G.S., on the subject of Ocean Telegraphy, and particularly in reference to that great problem of the day, "Telegraphic communication with America;" and as Mr. Davis accompanied Capt. Allen Young in the yacht *Fox*, in 1860, to ascertain the practicability of the northern route, as marine surveyor, his observations are entitled to respect, both with regard to the merits of the two great lines under discussion—the direct, between Ireland and Newfoundland; and the northern, *via* Fœroe, Iceland, Greenland, and Labrador; and also in regard to the nature of the cable best suited for deep sea telegraphy. Mr. Davis exhibited a number of specimens of cable, also diagrams of the ocean bed on both lines. In the course of his lecture Mr. Davis said that one strange circumstance connected with the Atlantic cable is not generally known, and that is, an American company has obtained from the colonial government at Newfoundland the sole right to establish telegraphs from that island and the adjacent coast of Labrador to the United States, and also the concession, to the exclusion of others, of landing wires on the coast, so that an English company could not land a cable on the shores of an English colony without the permission of a foreign company. £70,000 was paid for that permission by the English company, with a certain royalty to be paid on every message transmitted. There was also a stipulation as to time, so that if we wished to take another cable across now, another subsidy would have to be paid for permission to land, and that it is that brings Mr. Cyrus Field over to this country. He is chairman of the American company that holds the concession, and is naturally anxious to finger another £70,000 of English money. The cause of the failure of the Atlantic cable has been fully explained, electrically, by Mr. Hearder in his paper read at the Plymouth Institution in December, 1858. I will merely point out its mechanical defects. With regard to that cable and cables in general (I am speaking more particularly of those intended for deep sea), here are several specimens of iron roped ones. They have been constructed as if they were meant to be paid out of a drawing-room window. There is not a sailor's cable amongst them; and here I may remark that I think fewer mistakes would be made if engineers would drop their exclusiveness, and take into their counsels a few scientific sailors. These cables are beautifully constructed, not a fault can be found in the regularity with which the component parts are put together. Their specific gravity is well ascertained; they weigh so much in air and so much in water. But the question is, are they practical both with regard to stowage on board a ship, and paying out, also regulating that paying out in a heavy sea; in fact, getting the cable to the ground without injury? I say I believe they are not; and I also believe that the iron wire which is meant to give such enormous strength is only a source of weakness, and not of strength; for a cable can be considered only so strong as it is in the weakest part. Now, this cable is cable is coiled on board a ship in huge coils; consequently, the lowest sheave of the coil is subject to the pressure of the superincumbent weight of the coil, which in itself is enormous. Gutta-percha is compressible, and softens at a low temperature. The heat of the ship's hold, especially if near the influence of the engine-room, all tend to injure the lowest sheave; and I do not believe that the lowest sheave is in the same order or condition when paid out as the upper. Again, the great weight renders them very difficult to regulate in running out without an enormous strain being put on them—a strain that must injure the cable; and in the case of the Atlantic, it having to pass over one wheel and under another of the break, the strain did not come equal on the strands, so that I cannot but believe that with a heavy strain on when the cable left the brake it was more or less injured; and so it will be will all iron-covered cables; the unequal tension in paying out over wheels of small circumference will weaken them. Strange misapprehensions are entertained by many talented men as to the nature of the bottom, with regard to its acclivities and declivities, and also of abrasion. They say a heavy cable is necessary to take up the inequalities of the bottom as the ship proceeds, for with a light cable the ship might be ten miles from over the spot when the cable reached the bottom, and it might stretch from one height to another without being able to take the inequality. Now we have nothing to prove that the ocean bed is anything but a gently, very gently undulating surface, and quite different from the land (a glance at the charts of our own shores at the outer soundings will prove that); and as to abrasion, excepting near to the shore, or in a strait, I have no faith in it at 30 fathoms water and upwards. In 1,000 fathoms water, where a 64lb. ball and a very small line reaches the bottom so gently that were it not timed you would be doubtful when it was down, the heaviest of these cables would reach the bottom like a flake of snow falling on the surface of the earth, and the most delicately constructed cable possible would be more free from injury in 1,000 fathoms than on the surface of the ground. Such is my opinion, so that (allowing the electrical conditions are perfect) the great desiderata in a deep sea cable is strength, small specific gravity, and small size; in fact, we want a "pay me out" cable, and not a "hold me in" one. With such a cable as I have described there would be no difficulty in coiling it on board ship, handling it, paying it out, and checking it if necessary. Let the ship go as fast as it is possible to pay the cable out with safety (with the certain per centage for slack), and then if in deep water it falls on knife edges it will not hurt. The best sailor's cable I have seen (but I must own I have not seen all), is the patent of Mr. Hearder. The conducting wire is coated with gutta percha or india rubber; then spinal cords of the finest twisted hemp—this is strength in the right place; over the hemp is a glutinous coating, of great use to repair the cable, for if the india rubber insulator were punctured with a pin, or nail, the glutinous coating would repair the damage without destroying the insularity. The hemp is again covered with gutta percha or india rubber, then completed with the hemp covering, either spirally or plaited. With regard to the selection of a suitable cable, there should be a committee of electricians, and all the different forms of cable submitted to them. Let them decide on those that possess the electrical conditions necessary. Then let a body of scientific sailors decide which is the best for laying; and the telegraphic engineer superintend the whole. One word with regard to the ship to lay the cable. I do not consider a man-of-war suitable for the purpose. A ship should be built for the purpose; everything, both in build and fittings, should be directed to the one purpose. As the cable run out, compensating weights for the cable paid out should be taken in, to keep the ship in trim. The very discipline of a wan-of-war is not conducive to the safety of a cable; the captain is supreme there in spite of engineers and electricians, and a command from him might risk half a million of money. I am of opinion that every one, even to the cabin boy, should have a stake in the safe laying of the cable. Manufacturers, engineers, electricians, and every man that puts his hand to it, should have something to gain or lose by its success or failure. What does a gang of men-of-war's men or mariners care about the cable? All they get is much extra labour and wear and tear of clothes. Men-of-war, if you please, for scout and pilot ships, but let them not touch the cable, except in case of necessity. After describing the northern route *via* Fœroe, Iceland, Greenland, and Labrador, Mr. Davis says—The one great difficulty on this route is from the Greenland coast, on account of the ice and ice-bergs, and the numerous gales to be met with off Cape Farewell, as off all continental capes; and it is to be allowed there are difficulties, and by no means to be considered lightly of, but they are not difficulties that cannot be overcome by the pluck, energy, and perseverence of Englishmen. It must be owned that it will require the best ships, the best men, and above all, the best captain, as a director of the whole, to be found. With these, and common sense on the part of the directors, shareholders, and the public, in not expecting impossibilities; not to be too sanguine, too impatient, too elated, or too depressed, I have no doubt of its practicability and ultimate success. As to icebergs, I have already proved that the Fiords are deep enough for the cable to lay in safety under the largest seen on the coast. The pack or store ice is a formidable opponent to meet with in the actual laying of the

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cable, although with proper care and circumspection I do not apprehend any danger there, as the arrival and departure of the pack ice is generally known, and can be avoided; but I will proceed to lay this portion of the cable. as it is the portion the difficulties of which so much stress has been laid on. We will suppose Julianchaab as decided on as the starting point; depots of coals being established at the various ports down the coast. Our ship, with the cable on board, and two pilot or scout steamers, will proceed in May to the coast, going direct into Julianchaab if they can, or proceeding north, and, taking their time, proceed south inside the ice. Arrived at Julianchaab safe, and all arrangements being complete, one of the pilot steamers will take up her position at Hollander's Island (an island and anchorage near the entrance of the Fiord), they will establish a station on the top of the island. We will take a growing moon; on the signal being made from the hill that no ice is in sight the pilot steamer will start out to an offing of 150 miles, the signal being made at the same time to the cable steamer to prepare, if the sea is clear of ice the pilot steamer sigalizes to the hill, on her return the hill to the cable steamer. Steam being up she drops the end of the cable and away she goes, gets the desired offing and away for Iceland—six or seven days with a light cable will lay it; the same process repeated will do for the Greenland and Labrador section. The arguments in favour of the Northern route are, that commercially speaking, the direct line will never pay; that supposing the expenses are equal, the transmission of messages will be no less than nine times greater by the northern than the direct route; that if there is a flaw or puncture in the direct upwards of 2,000 miles of cable and the whole capital of the company is gone, whereas by the northern only a section in which the fault lay would be lost—an axiom agreed to by all that it is better to lose a part than the whole; but the strongest argument I think is this: A contractor is to be found to guarantee the efficiency and satisfactory working of a cable 2,100 miles long, provided (mark the proviso) "that it be laid and maintained in the condition as manufactured by them." That is something like the Dutchman who had 100 reasons for not firing a salute, the first being that he had no powder; the other 99 were dispensed with. Who could prove, with the cable once down, that it was or was not laid in the condition manufactured? Then again, an important condition is left out, viz., the rate at which it will work, how far the northern contractors are to be found to take the responsibility of laying and working the northern line, and that at a less cost than the direct route; that argument speaks for itself. I have had somewhat to do with the northern route, but I beg to be understood that I have no personal interest whatever, either now or in future, in the success of the one line or the other, in one cable manufacturer or another, and I am not here to advocate any interests. I have done my best to point out the advantages and disadvantages of both lines, but I am of opinion that if America is to be connected by telegraph with England it will be by the northern route—time will show. If others differ, as doctors will, let them lay another direct line, there is room and work enough for a dozen, but let me advise any intending shareholder of the direct to hedge in with a few of the northern, and keep an account of his returns.

PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

Fine	2s. to 2s. 3d.	per lb.

INDIA RUBBER.

Fine Para	1s. 11d. to 2s.	per lb.
Negro	1s. 0d. to 1s. 1d.	„
Java	1s. 4d. to 1s. 5d.	„

March 20, 1862. WM. KIRKMANN.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do. B 7 per cent. till 1862 .	all	18 to 20	———
20	Do. C. „ „	all	9 to 11	———
Stock	Electric Telegraph . .	100	98 to 101	———
10	Mediterranean Extension Tel.	all	4 to 5	———
20	Red Sea and India Telegraph	all	18¾ to 19½	———
1	Submarine Telegraph, scrip.	all	3/8 to ⅜	———
1	Do. registered . . .	all	3/8 to ⅜	———
10	Do. „ . . .	all	4 to 5	———
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	———

Telegraphic News.

ELECTRIC TELEGRAPH SERVICE OF INDIA.

SIR C. WOOD (in answer to Mr. White) said he believed there had been some recent complaints from India of deficiencies in the working of the electric telegraph, mainly owing to the employment of native signallers. Representations having been made to the Indian Government, a committee was appointed, and the result had been that the department had been reorganized. With regard to any particular appointments, he must remind the hon. gentleman that they were all made in India. The Home Government did not interfere with the appointments made in India, unless some special ground was shown for its interposition. He had not the least reason to suppose that any improper appointments had been made over the heads of qualified servants. With regard to two of the officers in question, he did not believe that two persons better qualified could be found either in the Indian or any other service. Two other officers had been for some time at the head of departments. Looking to the anxiety of the Indian Government to put this service on a proper footing, he had no reason to suppose that any improper appointments had been made.

Intelligence has been received by the Telegraph to India Company that the new station at Jubal Island, in the Red Sea, is open, and ready for messages. The Postmaster-General has given permission for the mail steamers to receive and deliver telegraphic despatches at Jubal, on their passage up and down the Red Sea, by which means a saving of from two to three days will be effected in the communication with the East.

UNITED KINGDOM ELECTRIC TELEGRAPH COMPANY.

THE Earl De Grey and Ripon presented a petition from the Leeds Chamber of Commerce in favour of facilities for the construction of telegraphs being granted to the United Kingdom Electric Telegraph Company.

Recent Patents.

1214. "*Decomposition of the compounds of aluminium, and coating metals with aluminium or its alloys.*" T. BELL, Gateshead. A Communication. Dated 13th May, 1861.

THIS invention consists in effecting the reduction of aluminium compounds, particularly the doudle chloride of aluminium and sodium, by the agency of voltaic electricity; and in employing the same means for the purpose of coating metals with aluminium. By this process the patentee converts the surface of copper into aluminium bronze.

The mineral cryolite, which readily furnishes aluminium under the reducing action of sodium, would probably constitute one of the most available sources for the preparation of this metal by the help of the galvanic battery.

2127. F. TOLHAUSEN, *Paris*, "*A new and economical method of producing dynamical electricity, thereby obtaining useful chemical compounds.*" A Communication. Dated 26th August, 1861.

THIS invention relates to a new arrangement of piles or batteries having constant and energetic currents, and yielding useful products at the poles of each element. The principle of this method is based on this theory, that the electro-motive power of a battery is proportional to the chemical action that takes place by the contact of a metal and an acid, which chemical action, on the other hand, is directly proportional to the caloric evolved—first, by the oxidation or decomposition of the metal by the acid; and, secondly, by the combination of the metal or metallic oxide with the acid used, the said chemical action being inversely to the absorption of caloric produced by depolarisation. In order to form a battery by this method the inventor uses a metal or an alloy, and esther a free acid or an acid that is combined with an electro-negative metal, so as to procure a very pure salt, which may be used in the arts directly or indirectly. In order to proudce an energetic current he uses such metal and acid as will give rise to a rather powerful chemical action, and evolve much heat, *e.g.*, iron, zinc, lead, copper, and silver, nitric and hydrochloric acids, and clorhydrate, sulphuric, acetic, and chronic acids. Nitric acid being used as a depolariser at the positive pole, yields the best results, because it depolarises by absorbing the hydrogen with the least absorption of caloric. In order to absorb the nitrous vapours, which are given off as in Bunsen's pile, he uses the oleine or oleic acid from fatty bodies, or non-siccative oils, which are thus converted into concrete, elaïdine, or elaïdic acid, and may be used for making stearine candles.—*Not proceeded with.*

2023. R. A. BROOMAN, *Fleet-street, London*, "*Coating wire with copper, silver, gold, &c.*" A communication. Dated 14th August, 1861.

THE object of this invention is to prevent rust or oxidation of wire, and the invention consists in coating the wire with copper, silver, gold, brass, tin, or other suitable metal or alloy in manner hereafter described. The wire to be coated is first passed over a roller or pulley, which is in connection with the positive pole of a galvanic battery, then under one or more rollers or pulleys immersed in a suitable bath or solution, and in which a piece of copper or other metal which is to form the coat is suspended by a platinum wire; this piece of copper being connected with the negative pole of the battery the wire in passing through the bath or solution receives a deposit or coating of copper; it then passes over a wooden roller or pulley outside the bath and through a vessel containing water, on emerging from which it is cleaned and dried by a cloth or otherwise, and then wound on a roller to be used as required. The bath or solution before-mentioned is prepared according to the metal or alloy with which the wire is to be coated.

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Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

ELECTROMETERS.

To the Editor of The Electrician.

Sir,—Would not the Milner or Peltier electrometer, when sufficiently well insulated, be preferable to the gold-leaf instrument for such experiments as those described in the article, "Steps to Theory," in your last (par. 96, *Exp.* 18)? It is sometimes difficult to measure by the eye the divergence of the gold leaves. In the Peltier, on the contrary, the deflections may be accurately noted by means of the index.

A Student Beginning Afresh.

[A greater and a lesser divergence are easily distinguishable in the gold leaves, and *comparative degrees are not required;* for such delicate experiments as those referred to we much prefer the instrument we have recommended to the Milner or Peltier arrangement; and, with respect to the highest intensities of static electrical action, we have reason to question the accuracy of the performance of that electrometer, *in common with all others having a horizontal movement, as they are generally arranged.* Even the expensive "Bifilar Electrometer" is not considered to be free from fault, for its inventor, Sir Wm. Snow Harris, reported of it in the *Philosophical Transactions* for 1836, that, *at particular distances*, certain of its indications were "apparently disturbed by some foreign influence," which the theory of the day was not able to indicate. We are going on step by step, and when "A Student Beginning Afresh," shall have accompanied us far enough, he will, we think, be able to see the causation involved in all this; that is, if he began with us at the beginning, and have not come tumbling over the wall into our company.—Ed. E.]

THE INDUCTION COIL.

To the Editor of The Electrician.

Sir,—I rejoice that in your useful work, "The Electrician," you have begun to discuss the induction coil. In your number for February 28th, you also give an interesting extract from Dr. Noad's little book on the subject. But though alluding to the condenser, you do not (nor does Dr. Noad's book) explain the use of the two studs, or connectors, which (in Ladd's coil machines) stand near the commutator, and do not come within view in the engraving you have republished from Dr. Noad's book.

I find, when they are used, an enormous increase of magnetic power, but with the greatest care in adjusting the break it will not act; it either adheres to the anvil, or else to the iron core, it will not vibrate.

How and with what class of experiments are these connectors used?—Yours dear sir, very truly,

An Enquirer.

PRACTICE AND THEORY.

To the Editor of The Electrician.

Sir,—In its first number The Electrician announced its intention to allow free discussion of new conceptions of causation, and I trust it will never be deterred from persevering in the good course upon which it has now fairly entered, until electrical doctrines become so true as to secure professional electricians against the stigma, and capitalists against the cost, of those lessons in the school of experience that proverbially are so dear, and in which we have been too prone to indulge, as is evidenced by our late signal and gigantic failures in telegraphic practice. How can we expect to get from electricity an unerring service until we have sought successfully to know its nature? What we learn from observation has the two-fold disadvantage of being at once costly, and not fundamental. We want sound elementary electrical theory. Does your correspondent, "Inspector," who throws so much emphasis upon the expression, "*practical* knowledge," imagine he can have, simply by asking for it, a text-book, or a multiplication table, of electrical causes and effects? or would he be content to be told in answer to his call for enlightenment, that some one else had had a wire afflicted with like fits of monomania—that it had been submitted to a similar course of pathological examination, and summarily cured by an exhibition of the same empirical remedy? The *italicised* word intimates, shall I say, his aversion to doctrine? certainly his dependence on the accidents of practice; but how limited are the teachings of practice? We see by what he relates, that he is as well qualified to be a practical electrician as his compeers, but he cannot expound the cause of the "fault" whose locality he has discovered; so that if he were to be commissioned to-morrow to lay down a new Atlantic cable, he could have no well-grounded confidence of not finding in its performance some "fault" that he would again have to regard as "singular." Will he then wish to appear careless about better and deeper electrical doctrines?

On the other hand, it appears to me, sir, that the letter to which I am alluding is suggestive of an useful lesson. Every one, authors and editors, who solicit public time and attention for the investigation of a new theory, ought, in reason, to confine their demands within a compass only commensurate with the importance of their communications, and "Inspector" may, perhaps, have pondered the question, whether The Electrician has lately been acting upon that maxim. For several weeks past many of its pages have been occupied by two distinct series of theoretical papers, the reading of which he may have considered too great a tax upon his patience, and so have discarded both, to save the trouble of making a selection. I will not presume to say it is so; but, in case it be, I will venture one or two remarks that may be useful. Of the two sets of papers, those which appear as editorial alone aspire to convey intelligible views of electricity and its forces—an aim important enough to encourage electricians to follow a course of argument for its investigation, provided they have not made up their minds to believe success in such an attempt impossible; any one who has thus abandoned hope of his own theoretical advancement, will, of course, take no pains to effect it. Does "Inspector" patronize only "*practical* knowledge" arrived at by leaps in the dark, to the exclusion altogether of theoretical deduction leading to the same end more circumspectly, more economically, more thoroughly, more certainly, and who shall say, less promptly?

March 15th, 1862. Au Revoir.

TELEGRAPHIC "FAULT."

To the Editor of The Electrician.

Sir,—Your correspondent, "Inspector," has not furnished your readers with a full description of the portion of the wire which exhibited the remarkable phenomenon he mentions. Was the wire connected to the iron arm one of copper, and what was the nature of the cement? A voltaic couple appears to have been accidentally formed, the effect of which was to neutralize the current which should have deflected the needle in question to the left.

The Post.

ON SUBMARINE CABLES.

To the Editor of The Electrician.

Sir,—Your correspondent "Momus" maintains that an insulator for submarine purposes should combine lasting durability with permanent non-absorbent qualities. I quite agree with him. We cannot hope to reach this absolute perfection, and the nearest approach to it we can obtain is the insulator *par excellence* for submarine cables. Now "Momus" discards gutta percha because it is *very porous*, and urges the adoption of india rubber because it is impermeable to moisture. Your humble servant, on the contrary, adopts gutta percha on account of its *non-absorbent qualities*, and discards india rubber because it is *very porous!* This is very paradoxical, but I will be more logical than your correspondent in supporting my views, and will give some better reason than the existence of the bright mid-day sun, for the porosity of india rubber. Your readers shall decide between the two learned doctors—"Momus" and "P. Q."—who so thoroughly disagree.

Firstly. Gutta percha is *not* porous. All my authorities are drawn from that valuable book the Government Report.

1. Mr. Canning: Question 1542—70. Does not believe in the permeability of gutta percha; it has been found perfect after eight years submersion.

2. Mr. Chatterton: 1066—67. Found no variation in permeability after long immersion.

3. Mr. L. Clark: 3559. "I believe gutta percha to be one of the most impermeable substances that has been used for insulation at present."

4. Mr. Hancock: 2157. Found after careful experiments that it did not imbibe water.

5. Prof. Thomson: 2593. Considered gutta percha impermeable.

I think from the above that your readers will arrive at a different conclusion than that to which your correspondent would direct them.

Secondly. India rubber *is* porous.

1. Mr. L. Clark: p. 334. "India rubber will probably be eventually found trustworthy, but its liability to occasional decomposition, and *to absorption of water*, will cast a slight shade of doubt over its character, which further experience will probably remove."

2. Prof. Miller, who specially examined this very question (p. 338), found pure white gutta percha porous, but does not mention the porosity of commercial gutta percha, as used for submarine cables. He, however, says: "Masticated india rubber is much *more* porous than unmanufactured caoutchouc, absorbs *a much larger quantity* of water than gutta percha, and the masticated much more than the unmanufactured or virgin rubber." Again, p. 340: "The absorption of water by gutta percha is very slight, indeed almost *nil* in sea water. In fresh water it is appreciable though trifling."

3. Mr. Fairbairn, who also examined this very question specially, and whose experiments, as well as those of Prof. Miller, are most interesting, found all insulating substances absorbed moisture to some extent, and he gives a list in their order of absorption. At the *head* of the list, as those materials which absorb least, are, Chatterton's compound and gutta percha, and at the *bottom* india rubber!!

I think your readers will be inclined to believe Messrs. Miller, Fairbairn, L. Clark, Thomson, &c., in preference to any anonymous writer, whose wish is evidently father to the thought, in denying a material that has done such good service to submarine telegraphy.

P. Q.

P.S.—Your correspondent, Mr. Cook, will find in the *Phil. Trans.*, 1836, that Christie fully examined the use of iron for the secondary wires in induction coils, and found that material much inferior to copper. Mr. Christie is the inventor of that beautiful apparatus, which is called Wheatstone's Bridge or Parallelogram. It is fully described in the above volume of the *Phil. Trans.*, seven years before its introduction by Wheatstone.

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METEOROLOGICAL OBSERVATIONS OF ADEN.

To the Editor of The Electrician.

Sir,—I beg to inclose a tabular statement of the temperature of the air and sea at Aden, at the mouth of the Red Sea, which may prove of some service to those engaged in laying a cable in that locality; and shall be glad to furnish any information that may be required with regard to tides, currents, &c.

No. 1.—A pair of black bulb thermometers in the sun, from 8 a.m. to 4 p.m.
No. 2.—A pair of self-registering thermometers in the shade.
No. 3.—A pair of ditto ditto and wet bulb.
No. 4.—A pair of ditto ditto in the sea at the depth of 3 fathoms.

The direction and force of the wind taken by Osler's Anenometer.

Mean of Four Years.	Thermometer in the Sun.			Dry Bulb Thermometer.			Wet Bulb Thermometer.			Temperature of the Sea.			Total Evaporation each Month.	Wind	
	Max.	Min.	Range.	Max.	Min.	Range.	Max.	Min.	Range.	Max.	Min.	Range.		Mean Direction.	Mean Force.
	°	°	°	°	°	°	°	°	°	°	°	°	in.		in.
January.....	130·0	84·0	46·0	82·7	73·5	9·2	76·0	68·0	8·0	75·1	67·5	7·6	4·205	E	1·75
February ...	130·0	85·0	45·0	85·0	71·0	14·0	75·5	68·0	7·5	76·0	68·2	7·8	4·710	E	2·50
March.....	136·0	86·5	49·5	86·0	71·0	15·0	77·0	65·0	12·0	80·3	71·5	8·8	5·147	E	3·30
April	138·0	90·5	47·5	90·0	78·0	12·0	79·5	73·0	6·0	88·0	78·5	9·5	4·564	E	1·75
May	152·4	98·6	54·8	93·0	77·0	16·0	84·0	73·5	10·5	95·5	83·1	12·4	4·819	E S E	1·75
June	152·3	100·2	52·3	98·0	83·0	15·0	85·0	73·0	12·0	94·4	84·3	10·1	6·120	S W	5·00
July	154·0	98·4	55·6	99·0	82·0	17·0	84·5	73·0	11·5	92·0	80·2	11·8	7·826	S W	13·00
August	142·6	91·0	51·6	94·0	76·5	17·5	85·0	72·0	13·0	89·2	76·4	12·8	7·214	S W	15·00
September..	144·4	100·	44·0	97·0	82·0	15·0	86·5	73·0	13·5	84·1	72·5	11·6	5·806	S by W	1·30
October.....	143·6	93·2	50·4	90·7	74·5	16·2	82·0	70·0	12·0	80·3	70·0	10·1	5·874	E	1·75
November...	142·7	92·0	50·7	90·0	70·0	20·0	80·0	68·0	12·0	76·2	68·0	8·2	4·808	E	3·00
December...	138·0	90·0	48·0	83·8	70·0	13·8	78·5	69·0	9·5	76·0	67·0	9·0	4·139*	E by N	1·40

"pervaded the entire interval between the elevation of 50 and 500 miles above the earth's surface. This illumination consisted chiefly of luminous beams of columns everywhere parallel to the direction of a magnetic needle, when freely suspended. These beams were, therefore, about 500 miles in length, and their diameters varied from ten to twenty miles, and upwards. The magnitude of the earth currents in America was such that "brilliant sparks were drawn from the telegraph wires;" "a flash was seen about half the size of an ordinary jet of gas;" "a spark of fire jumped from the forehead of a telegraph operator, when his forehead touched a ground wire;" "streams of fire were seen when the telegraph current was broken;" "a flame of fire followed the pen of Bain's chemical telegraph." In Norway, "sparks and uninterrupted discharges were observed;" "bright sparks were noticed on the conductors of the telegraph lines to Bordeaux;" "paper, and even wood, were set on fire;" "magnetic helices became so hot that the hand could not be kept on them;" "the heat was sufficient to cause the smell of scorched wood and paint to be plainly perceptible;" "a flame of fire burned through a dozen thicknesses of paper; the paper was set on fire and produced considerable smoke." In Norway, "pieces of paper were set on fire by the sparks, and it was necessary to connect the lines with the earth, in order to save the apparatus from destruction;" "some of the telegraph operators received severe shocks when they touched the telegraph wires;" "at Washington the operator received a severe shock which stunned him for an instant;" "on several lines it was used as a substitute for a voltaic battery in the ordinary business of telegraphing;" "the intensity of this effect was estimated to have been at times equal to that of 200 cups of Grove's battery;" "in Switzerland the currents were at least three-fold the ordinary current employed in telegraphing."—*Proceedings of British Meteorological Society.*

TELEGRAPHIC MISTAKES.—The similarity of letters used in signalling by telegraph, and also the omission of proper stops in the messages, hastily written by the public, often cause errors of the most ludicrous nature to occur. Thus, a gentleman who had ordered his *gig* to meet him at the station, was understood to require the attendance of his *pig*; while a merchant received an order to ship "forty tons of *fog* to the Mediterranean," the novel cargo having been manufactured from the letters usually accompanying an order to deliver goods *free on board*. "Your wife has a fine *box* this morning," was intended to intimate the birth of a son; the letters *x* and *y* being very similar. "You can have the hundred pieces at sixteen and nine—thousand more at the same rate," was delivered "You can have the hundred pieces at sixteen, and nine thousand more at the same rate." We don't know if the bargain stood good when the error was discovered. "Don't come—too late," was a message once sent from Edinbro' to a doctor in London, but being delivered without the pause, it read "Don't come too late," upon which he started off, and only discovered the error after a journey of 400 miles.—*Dodwell's Illustrated Handbook to the Electric Telegraph.*

ELECTRIC TARGET TRIAL.—An experiment of a very interesting character to volunteers was made on the 14th inst., at the range of the St. George's Rifles, at Wormwood Scrubs, and a number of gentlemen of rank and position connected with volunteer regiments were present, among them Lord Elcho, M.P., W. Wells, Esq., Mr. Evans, M.P.; Colonel Wood, Paddington Rifles; Captain Fenton, West Middlesex; Major Ives, St. George's; Captain Pugh and Lieutenant Humphreys. The Metropolitan Rifle-range Company having adopted the targets of Messrs. S. C. Hemming and Co., who have bought the patent of Mr. Chevalier, commenced a trial of an electric target, at half-past one o'clock in the afternoon. The principle of the patent is as follows:—The target is divided into ten portions —bull's-eye, centre, left, right, upper, lower, upper left, upper right, lower left, and lower right. As a shot strikes any one of these divisions a ball at the back is driven away with some force, and by its percussion completes the electric circuit, the needle on the indicator at the firing point making a notation corresponding to the impingement of the shot. Twenty-eight shots were fired at the 150 yards range, and all of these were exactly indicated, with one exception, the failure of which was owing to a break in one of the wires, which were all much too small to stand the work. Removing to 400 yards, other 28 shots were fired, and all the hits out of this number were exactly recorded on the indicator. Considering the disadvantages under which the trial was conducted, the experiment must be regarded as eminently successful. Doubtless, when the target is properly and permanently fixed, and the indicator is not liable to accident and disturbance by being shifted from place to place in a truck, the invention will show up better than it has done. As it is, however, we have seen enough to convince us that in the invention there are the germs of a complete revolution in the system of marking. Ere long we shall be able to get rid of the expense now incurred by paying a staff of markers, since the wages of a marker for one year would buy a machine, which will last for many years. More than this, by a different arrangement of the sections or divisions of the target the marking will come to be more exact, and this is a desideratum which the council of the National Rifle Association will do much to bring about, if, as appears probable, they will at the next Wimbledon meeting adopt a new arrangement in marking for the all-comers prizes. We must congratulate Mr. Hemming and the managers of the Metropolitan Rifle-range Company upon yesterday's success, which, although but qualified, affords a guarantee for the ultimate triumph of the principle. We trust that a "fixed" trial may soon be made, when we shall be pleased to chronicle the results, and all the more readily if, as we expect, they should turn out to place the success of electric targets as opposed to individual marking beyond a question. It is clear that, when once arranged, wires can have no favourites, and they do not become sleepy or lazy, as volunteer experience shows that markers have an unpleasant habit of doing now and then. [A plan similar to the above was described in the *Mechanic's Magazine*, September 18, 1847.—ED. E.]

RELATIVE SIZE OF BATTERY ELEMENTS.—In a well-constructed battery working in short circuit no hydrogen gas should be given off from the surfaces of the amalgamated zinc elements. The evolution of gas from the positive element would in this case shew, either that the surface of the negative element is insufficient, or that the fluid resistance in the battery occasions a loss of quantity in the current, and a wasteful consumption of zinc. When the zinc is immersed in a strong acid mixture, its surface should be comparatively small to that of the negative element, as in the ordinary form of Daniell's battery, with the outer vessel of copper. On the other hand, when the zinc is immersed in pure water, or a solution of sulphate of zinc, as is usual in batteries for telegraph service, the amount of negative surface may be reduced. In the French telegraph batteries, the zinc element surrounds the porous vessel containing the copper element; and this arrangement is found to give greater quantity in the current than the converse method of surrounding the zinc element with a cylinder of copper. The surface of the negative element may at all times be increased without positive disadvantage in regard to battery expenditure; but in many voltaic arrangements, such as the ordinary form of Smee's battery, and perhaps in that of Bunsen, the waste of zinc, owing to an unnecessary amount of surface, is very considerable.

COMPOUND OF IRON AND AMMONIUM.—Dr. Meidinger (*Neues Jahrb. fur prakt. Pharm.*, Bd. xvi. s. 295) says, that a voltaic current passed through a mixed solution of a protosalt of iron and sal ammoniac produces a bright metallic precipitate which resembles polished steel in appearance. It forms a very thin casing on the pole which scales off as the deposit increases. Carefully rinsed with a good deal of water and dried on blotting-paper, it evolves, when treated with a caustic alkali, a strong smell of ammonia. When heated, the smell is also perceived, but is quickly dissipated. The precipitate, when put into water and heated nearly to the boiling point, evolves a good deal of hydrogen. The author has no doubt that the precipitate is an alloy of iron and ammonium; others, perhaps, will think differently. The most ammonia he found in a precipitate was 1·5 per cent.—*Chemical News,*

To Correspondents.

L. L. S.—The fault of your galvanometer appears to be, not in the degree of magnetization of the needle, but in some defect in the pivotting. We generally magnetize our needles by passing the poles of a small magnet along them *in one direction only*. You cannot expect very much power with *one* battery cell, however large, even through the small resistance you mention. What is the difference in the deflection of the galvanometers with the battery in short circuit, and with the resistance of the line wire included? This difference represents loss of power due to insufficient tension in the current. The "fickleness" of the electro-magnet may probably be traced to a defective connection somewhere. Copper wire becomes oxidised, and its surface is then a bad conductor; the terminal wires of the battery and of the galvanometer should be amalgamated or brightened before connection is made. It is not always easy—sometimes very difficult to get "good earth" (see p. 222 in our last). In testing for *leakage*, a delicate galvanometer is required to discover small faults. With good earth contacts the earth gives no appreciable resistance in the circuit. What is the nature of the soil in which the plates are buried? *Exp.* 2 shews satisfactorily either that the two earth plates virtually constituted a voltaic couple, sufficiently powerful to influence the needle instrument, though not the quantity galvanometer; or that your wire (copper) was in metallic contact with a positive, such as the iron of the piping through which perhaps you had passed it. Copper surrounded with charcoal would be negative to copper simply buried in the earth; and thus you may possibly have formed an active couple, with the earth for a battery cell.

J COOK.—We refer you to the article on the "Induction Coil," in the present number. An instrument as powerful as that described by Dr. Noad might be constructed with iron wire, but would require to be of larger size. In proportion to the conductivity of the wire is the *quantity* of electricity set in motion in the secondary coil. *Ceteris paribus*, the *tension* depends upon the number of turns of wire in this circuit, consequently you will perceive the inexpediency of adopting the system of separate coils in the secondary circuit, your object being to obtain tension effects. You might decrease the size of the secondary wire, at the same time increasing the diameter of the core of soft iron, with advantage in point of tension, and not necessarily with loss of quantity. Of course, the brilliancy of the phenomena of the coil greatly depend upon the quantity of electricity in motion. Your communication now in hand will receive attention next week.

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The Electrician.

Vol. I. No. 21.—March 28, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 231.]

120. We have sometimes thought a profound sage must have written the story of Aladdin's lamp to shadow forth how the light of human knowledge turns into palaces all the dreary wastes it shines upon! But be that as it may, we undoubtedly are now finding out how a little true electrical doctrine can diffuse a light around it that penetrates into crevices and nooks of mystery, and dispels a gloom that has long enshrouded us in an impenetrable ignorance, and kept us destitute of one of the mightiest engines at the disposal of man. If there be any who are not finding this out, it will be those who have not accompanied us step by step in our arguments, and to them we are quite at liberty to say we are not addressing it, as they have not qualified themselves to be judges in the matter. If they will go back and follow the course of our reasoning, we shall have no fear other than may arise from our liability to err in not making our meaning at all times clear; it is sometimes less easy to teach than it is to learn, for when once a conclusion has been arrived at and satisfactorily confirmed, we may retain it securely in our memories, and carry it along with us, while we permit parts of the argument to slip away and be forgotten. Should it be made known to us by any of our readers (and we invite all to do so), that we have failed in being conclusive on any point touched upon, we shall acknowledge ourselves thankful, and immediately supply what is deficient.

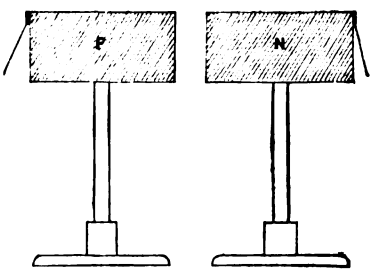
121. Already our simple theory of a definite electrical attraction has furnished us with three different means of augmenting electrical charging capacities, all of them dependent upon the same causations; 1st, By "exposing" a conductor of given surface more freely to the atmosphere (par. 80, figs. 7 and 8). 2ndly, By extending the conducting surface upon which the charge is to rest (par. 114); and 3rdly, By placing a charged conductor in conducting communication with another contiguous to it, but from which it can separate or be separated (par. 116). To these other means of increasing the charging capacities are still to be added.

122. Procure two cylinders turned out of pine, each about three inches in diameter and six in length, with flat ends. Cover them with tinfoil, and mount them on separate insulating supports, such as those used for the wooden spheres (par. 35), in such a manner that they may be brought together with two of their flat ends, or faces, wholly in contact. Supposing them to be so placed, attach to each of their outer faces a slip of Dutch metal, about two and a half inches long and half an inch wide, suspended from a small square of thick paper, or a shaving of cork, pasted to the upper part of the face, and so that the metallic leaf shall hang flat against it.

Exp. 20. The insulated cylinders being prepared as described, place them upon a table in a line with one another, but about a foot apart, and communicate to either of them a plus electrical charge just sufficient to cause its metallic leaf to diverge freely from its outer face; then, holding the other cylinder by its foot, slide it towards its fellow until its plain face arrives within about an inch of that of the other, and with the two parallel. By the time that is done the metallic leaf of the charged cylinder will have its divergence lessened, showing a reduction in the electrical intensity of its charge, or as we might express it, showing an increased electrical capacity by virtue of its new position relatively to the other cylinder, for under the circumstances it could receive a larger quantity of plus electricity, and still its intensity be no greater than it was originally.

While the divergence of the metallic leaf from the charged cylinder has been diminishing, the leaf of the other cylinder will have commenced to separate from its face, showing that the uncharged conductor has departed from its normal, or natural condition, and become electrically charged, as well as its associate, from which it is separated by a thickness of insulating atmosphere. We will illustrate this state of things by a diagram, as we shall have to make other references to it.

Fig. 21.



The theory of the case we shall consider presently, we must now confine our attention to the facts. In the above figure P represents the charged cylinder, and N its associate, which has, by reason of its position relatively to P, somehow or other become charged; now, if we separate P and N to any considerable distance, the full divergence of the metallic leaf of the former will be restored, and that of the latter wholly cease. But while the distance between the two cylinders remains unaltered both the leaves will continue to diverge, the divergence of that which received the plus charge being always the greater of the two.

We will now put the proof plane (par. 96), into requisition. Holding it by its insulating handle (which should for this use be cemented to it at an angle), introduce its disc between P and N, laying it flat upon the face of P; if we then withdraw it, and bring it into contact with the brass fittings of the gold-leaf electrometer it will communicate to it a plus charge, which may be distinguished by the divergence of the leaves diminishing on the gradual approach of sealing wax that has been rubbed against woollen, or by the divergence increasing if glass rubbed with silk be presented to the electrometer.

Introduce the proof plane a second time, but now place it against the face of N; on transferring its charge to the electrometer and testing it, as before, it will be found to be electrically minus. Lastly, bring the plane against the outer face of either P or N, or the cylindrical parts round about those faces, and it will then in either case give up to the electrometer a plus electrical charge.

123. The facts we observed in the experiment, and which we have theoretically to account for, are therefore these; plus electricity on the insulated conductor P had its intensity reduced by the proximity of another insulated conductor N in its normal condition; while N, by its proximity to P, acquired a similar electrical charge at its more distant parts, and an opposite charge on its proximate face.

124. Now for the theory of those facts. In the beginning we had the cylinders P and N at so great a distance from one another that when P was made plus electrical the sensible inductive

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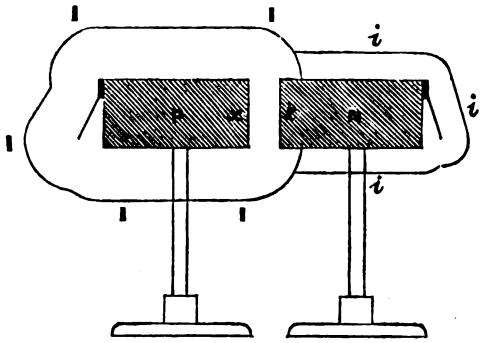
action of its charge bounded in the following figure by the line

Fig. 22.



I I I I I did not reach so far as to any part of the cylinder N, which being then in its normal condition had of course no inductive atmosphere at all. In that state of things the metallic leaf diverged from the face of P for precisely the same cause that the two balls in figure 18 tended to separate from one another as in figures 19 and 20; the other metallic leaf, in the absence of electrical charge, resting close upon the face of N. Then by pushing forward the uncharged cylinder towards its fellow, we caused its near face to penetrate the field of inductive action. In that position part of the inductive atmosphere of P was dislodged by part of the neighbouring solid conductor, which thereupon performed the office of the air so displaced, its common matter setting free some of its natural electricity to be a plus inductive charge (par. 74), destined to act immediately on some other matter in its normal condition.

125. Now here another feature of the theory presents itself for our consideration. The cylinder N is not an insulator like the air, but an electrical conductor; the electricity of its plus charge by induction was therefore not confined to its normal locality, that is to say, to its own common matter which it had ceased to attract; but, spreading over the whole surface of the conductor, it found a more extensive inductive atmosphere than it could have had by remaining on the face where the induction had set it free. By this new distribution the near face of N was left minus of some of its electricity, all its other parts becoming surrounded with a small field of induction, *i i i*, commensurate with the feebler intensity of its charge, while the intensity of P at the same time suffered a corresponding reduction.

126. Thus we have to add to our former number a fourth means presented by the theory for augmenting electrical charging capacity, which may be described as consisting in causing charges originated by induction to distribute themselves over the surfaces of insulated conductors freely surrounded by the atmosphere, when the original electrical charge itself is cut off from so dispersing itself over the additional surfaces, by intervening insulation.

127. This will be a proper place to branch off into another of the numerous classes of phenomena that take their origin in static induction. We say another class, although the line of demarcation between classes is hardly to be made out, and we would guard ourselves against being misunderstood to mean more than we really do by the expression. In electrical phenomena we can trace certain similitudes and differences, and the latter it has been customary to refer to varieties in causative force, a practice that has set up a barrier between things not naturally severed in their origin, which we now find it difficult to break down. There are probably but few causative forces in nature, and certainly we regard it as a sure token of the natural origin of our general system of electrical action that all its artificial divisions claim kindred with one another, declaring themselves to be collateral branches derived from one and the same stock, and showing palpably in their features an unmistakeable blood-relationship. And we presume our readers will not have been disappointed if they have already discovered that we cannot well mark the boundary lines of the classes into which we are dividing electrical phenomena, nor prevent their running into one another.

128. What we have now to speak of is electrical attraction, or the phenomena so called, and which we shall trace to the force of attraction, as we have already done the phenomena of electrical repulsion.

129. Examine a little further fig. 22, and let us suppose that, instead of the cylinders being rigidly fixed to their places by reason of their weight, they were very light, and suspended in the positions shown in the diagram by long insulating threads of silk. It may be conceived that under such circumstances, P and N would be free to move under the impulse of any slight force acting upon them, and our theory teaches that the electrical attraction will be such a force tending to bring their faces into contact; for the inductive plus electricity at *x* will be acting upon the inducteous common matter at *z*, and *vice versa*. The effect of that action (the impediment of gravity being supposed to be sufficiently removed) would of course be, first, a shorter distance between the opposed faces; secondly, and in consequence of that diminished distance, N would sustain more of the induction of P, the attractive force between them thus becoming more intense, their distance would be still further lessened; and thus the induction would increase, and the distance diminish, until the process were put an end to by the faces of the two cylinders arriving in contact.

130. What would therefore take place is this: P and N would equally divide between them the plus charge originally placed upon P, as we observed to be done by the insulated spheres in experiments 12, 13, and 14, (par. 41,) and thus assume the condition depicted in fig. 18 (par. 115), each cylinder depriving the other of part of its inductive atmosphere, to recover which the two would separate to just a sufficient distance, exhibiting an apparent repulsion for one another, as illustrated by figures 19 and 20.

Exp. 21. The student may institute practically the counterpart of all this by a very simple contrivance; if he suspend by silk threads two pith balls, and then charge either of them, on slipping their points of suspension gradually closer together, a certain short distance will be attained, sooner or later, depending on the intensity, through which the balls will suddenly rush together, and immediately after separate.

131. It will be seen that as yet we are applying our doctrines to electrical attractions only so far as they relate to conductors *both* of which are insulated; we have much more to explain concerning the attractions as exhibited by conductors, one of which communicates freely with the ground by uninsulation. But before we turn to that branch of our subject, we must instance another case of the two-fold insulation, because it is highly instructive, and should of itself, one would think, be enough to refute the old doctrine of repulsive forces, even if it were incapable of confirming the causation we are explaining, which, however, it certainly will do with very great minuteness. It has long been observed that when two insulated bodies—pith balls, suspended by silk threads, for example—are unequally charged with electricity, they repel one another at certain distances, and attract each other when closer together. Considered as effects of forces of opposite natures, these are, and we think must ever remain, very perplexing facts; for how can we imagine that a force acting from a given centre effectively at one distance, is to succumb at some shorter distance to another force acting towards the same centre, and that too while—as we find taught, and under the old theories should be compelled to believe—both forces varied inversely with the distance in exactly the same ratio! Well may those who have striven to use the two forces, not knowing of any better alternative, be almost universally silent as to this difficulty. But our theory affords it an easy solution.

132. Let *a b*, (fig. 23,) be two pith balls, suspended by insula-

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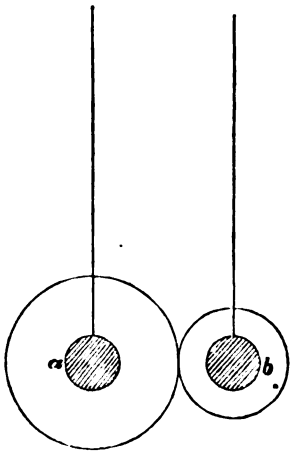
ting threads, both charged with plus electricity, the charge of *a* being so much greater than that of *b*, that the intensities of the

Fig. 23.



inductive action on the atmosphere surrounding the two balls may become insensible at the boundaries marked in the figure. Then although the inductive atmosphere around *a* will be much larger than that around *b*, all the particles of air forming the surfaces of the unequal spheres of air will be held in position with equal forces, the artificial equilibrium in *a* and *b* individually being perfect; therefore, so long as neither the weight of either ball, nor any other cause, interferes to disturb this state of things, the practical result will be what is known as electrical repulsion, and which will become manifest on any attempt being made to initiate a diminution of the separating distance.

133. But there are means available for disturbing this artificial equilibrium of the electrical attraction (par. 87), and overcoming the force by which *a* and *b* each retains the extreme particles of its inductive atmosphere; such, for example, as bringing their points of suspension closer together, by which their gravity will be brought to counteract, to some greater or lesser degree, the electrical force of induction. If by that, or any other means, the distance between *a* and *b* be gradually made less, the state of things will pass from what is above represented to, in principle, that we have just described with respect to the cylinders. After the distance has become shortened to a sufficient extent (the two inductive atmospheres meanwhile increasing as when we suppose fig. 19 to be passing into fig. 18), the body of *b* itself will have penetrated the inductive atmosphere of *a*; its nearest part will thereupon sustain some of *a*'s inductive action, dismissing a portion of its own natural electricity to wander over the other parts of its surface, to find greater facility for acting inductrically; and leaving its common matter to be an inducteous minus charge, attracted by the plus charge of *a*, and, by thus giving a new direction to the one only electrical force, seem to change a repulsive action into one of an opposite nature.

134. The only commentary we need append to this theory of electrical attraction and repulsion is to bring into contrast with it the only other explanation of the conversion of one into the other that we have ever met with. The student may find it in one of the most able of recent publications on electrical science, and we quote it in order to make more generally known the assemblage of incomprehensibles from which our doctrines are providing a refuge. "Electrical repulsion being dependent on limited inductive capacity and influenced by inductive changes subversive of the already existing electrical states, will be always open to great irregularity and disturbance, so much so that when the forces are unequal one of the electricities (plus and minus conditions) gives way, and in all cases the electricities yield more or less to each other's inductive influence; hence it is by no means an unfrequent occurrence to find two electrified bodies repel at one point of distance and attract at another." This language, after a critical examination of its meaning, may be received as about as good as any that could be suggested by a mass of observations that were confessedly unintelligible to the writer of it; but if we are to know no more about the causation of the facts than such language teaches, the darkness of electrical theory will certainly have been made visible. Happily, however, better instruction is within our reach.

(To be continued.)

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 233.]

Having given a few illustrations of inductive circuits, I will now proceed to the investigation of some of the effects produced by altering the resistance of the inductive circuit, when that alteration is produced by a change in the dimensions of the dielectric forming one of the inductive resistances in that circuit.

In order to do this, we must first consider the general form which the resistances may assume. It is evident that as the inductive resistance may consist of the dielectric intervening between the exterior surface of any irregular solid, and an outer irregular bounding surface, the investigation of such resistance must in many cases become so complicated as to be beyond the reach of any calculation or formula.

The more regular figures, such as the dielectric intervening between a spherical surface contained concentrically within another, (or, in fact, a *shell of dielectric*,) are within the reach of calculation as regards the ratio of their resistance to their dimensions; and indeed, although I have not yet given the formula for this, the general law which it must follow, has been geometrically illustrated. Again, in the case of *cylinders* of dielectric, the relation of their dimensions to their resistance has been given, and the relations between the dimensions of a *prismatic* dielectric and its resistance has formed the basis on which the others have been investigated.

We can therefore determine in these three cases the effects on their resistance of altering their dimensions.

Of these three cases however, the spherical shell, it will be seen, is the only one which could form absolutely the *only* resistance of an inductive circuit, and in which circuit therefore the total quantity generated, however the dimensions of the shall be altered, will be resident on the surfaces of that shell, and consequently will vary, in some definite ratio with the alteration of its dimensions. For in such case, as the two complete surfaces are the only surfaces in the circuit, since they entirely bound the dielectric, the total quantity generated must be resident on them. Furthermore, as all portions of each surface are under similar conditions, the accumulation on each surface is uniform.

If we could obtain this entire and absolute inductive action between two *equal*, *flat* and *parallel* surfaces, so that the *whole* of the generated electricity would be resident on those surfaces, whatever distance we separate them, the laws of accumulation could be more easily demonstrated, and would become far less intricate.

On a little consideration of what has already been pointed out with regard to inductive action, it will be seen that these conditions are rigidly impossible, and that we can only approximate to them.

Thus, if we have two flat plates opposed to one another, and attached to the two poles of a source, and insulated from the surrounding surface, as in fig. 30, a portion of the total quantity generated and distributed on them, will be due to the indirect inductive action to the surrounding surface, and consequently, if the plates be separated to various distances, the total quantity accumulated on them will not give us strictly the ratio between the *distance* separating them and *the quantity accumulated by the direct action between them.*

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If we had a flat plate opposed to a flat plate elevated above the earth in the open air, we should, perhaps theoretically, approach more nearly to the conditions named, but there would still be a certain amount of inductive action between the edges of the plate and the surface of the earth, and this would not decrease (for reasons which will be explained further on), in the same ratio as that on the rest of the plate when the distance between the plates is increased.

The case of a complete inductive circuit composed *solely of* a prismatic inductive resistance, although taken *à priori* as the basis of all the others, is one which in reality, therefore, can never be absolutely and rigidly obtained.

For similar reasons it is impossible absolutely to obtain an inductive circuit solely between two cylindrical surfaces. For if we suppose the surfaces cylindrical, with flat or hemispherical terminations, then the dielectric between these surfaces at the ends forms part of the inductive circuit, and consequently the inductive circuit is not confined to the dielectric between the cylindrical surface, whilst the inductive resistances between these terminating surfaces, could not follow the same law as that between the cylindrical surfaces. If we suppose the two cylindrical surfaces unterminated by any surface, then either both cylinders must be insulated from the earth, in which case there must be an indirect inductive action between the terminating edge of the cylinders carried on to the surrounding surfaces; or else, if the outer cylinder is connected to earth, then there will be a certain amount of inductive action between the circular edges of the interior cylinder and the surrounding surfaces.

We cannot, therefore, in practice, obtain inductive circuits composed entirely, either of prismatic or *cylindrical* resistances absolutely alone, so as to follow strictly the law we have seen which exists between their resistance and an increase of distance between the surfaces.

Since we cannot obtain prismatic resistances solely, it is impossible in practice, therefore, to obtain two surfaces so placed that the inductive action shall have taken place entirely between them, so that when separated, the total inductive resistance shall increase directly as the distance between the plates is increased; or so that when increased in surface equally, the inductive resistance shall actually decrease, directly as the surface is increased. We may, however, so approximate to these conditions that the error may be neglected. Thus, if we have two flat plates placed close to one another, and widely separated from surrounding objects, the inductive action will take place principally between them, and thus the total quantity accumulated on the plates will be nearly all due to the direct action between them. If further separated within certain limits, the inductive action to surrounding objects will not be much altered, whilst the inductive resistance between them will be increased directly as the distance.

If we take two cylinders, the one enclosing the other, then if their radius is large, compared to the thickness of the layer of dielectric separating them, if the dielectric be doubled or trebled in thickness, the inductive resistance will be very nearly doubled or trebled. And if we maintain the thickness the same, and increase the total surfaces of the cylinders, we shall decrease the inductive resistance very nearly in the same proportion. The error being solely due to their terminations.

If we have very long cylinders (such as a submarine cable), then since the effect at their ends may be entirely neglected, the increase of their length will proportionately decrease the inductive resistance.

If we suppose the surfaces spherical, the one enclosing the other, then, as we have seen, all the inductive action will take place entirely between them, and if they have a large radius compared to the distance between them, they may be treated within certain limits as flat surfaces; so that when the distance separating them is doubled, the inductive resistance is approximately doubled, and if we increase their surface (by an increase of diameter) without increasing the distance between them, it will produce nearly the same decrease in the inductive resistance, as if the surface of flat plates were increased to the same amount.

Whether any *given* resistance of an inductive circuit be a prism, a shell, a hollow cylinder, or any other figure, it will produce the same effect on the surfaces of any other successive resistances forming part in the inductive circuit; and any given alteration of this resistance (as, for instance, if it be trebled, doubled, or halved), even if its shape be at the same time altered, will produce a definite alteration in the resistance of the circuit. For the purposes of investigating the effect produced by altering the resistance of any *one* part of a circuit on the *other* parts, it would be immaterial, therefore, what shape we supposed that resistance to be.

But if we wish to investigate the alteration in the degree of accumulation or density produced on the bounding surfaces of a resistance by *its own* alteration, then it will be seen from the laws already laid down with regard to the resistances of shells and cylinders, that in some of these cases the problems would become complex. For we cannot alter the resistance of a shell or cylinder without increasing or decreasing one or both of the surfaces on which the electricity is distributed, and that not in simple ratio to the increase of this resistance itself, and consequently, the determination of the density in a circuit composed of several successive resistances, would form somewhat complicated calculations.

If, however, we could obtain a circuit composed entirely of prismatic resistances, since these could be altered in resistance without altering their surfaces, and since, if their surface were altered, an alteration in the resistance would take place inversely to the increase of the surfaces, the investigations would become much more simple, and would form steps which would give us an insight into the general laws of inductive action.

Although, as we have seen, we can never obtain an inductive circuit which shall be absolutely and rigidly composed solely of prismatic resistances, yet we can in practice (as already pointed out), approach very closely to these conditions, whilst for the purposes of investigation we may *suppose* or *assume* such a circuit. We can thus investigate the effect produced by altering one resistance of an inductive circuit on the total quantity produced, and on the density on each of the sets of surfaces terminating each prismatic resistance, when that alteration of resistance is produced either by an alteration in the extent of the surfaces, or of distance between the terminating surfaces. We can thus arrive at the general effects which would be produced in any real circuits, composed of the resistances of the dielectric between even spherical or cylindrical surfaces, within the limits of conditions allowing of their being regarded practically as prismatic resistances, whilst it will give us some general laws which could, by further detail and calculations, be modified strictly to circuits composed of several spherical or cylindrical resistances.

Let us suppose, therefore, that the inductive action can take place entirely between any two flat and parallel plates, so that we can treat them as prismatic resistances.

Then since the inductive resistance between two parallel surfaces increases directly as the distance separating them, or *length*, is increased, and decreases as their surface is increased, the resistances of two different sets of opposing plates will be proportionate to the quotients of their *lengths* divided by their surfaces.

Thus, if we have one pair of plates (r), whose distance apart is 9 units of length, and surface 5 units of surface; and another pair (r'), whose distance apart is 1 unit of length, and surface 8 units of surface; then the resistance of the first pair would be to the second as 9-5 is to 1-8, or as 1·8 is to ·125.

And if we suppose a unit of resistance to be the resistance between a pair of plates of a surface equal to unity, and separated a unit of distance, then 1·8 and ·125 would express the resistances of r and r' in terms of this unit of resistance.

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We can, therefore, substitute for any given prismatic resistance an equivalent one having a *given* surface, by making its length such, that the quotient of this length divided by the surface, shall equal the quotient obtained by dividing the length of the given resistance by its surface.

Thus, if it be desired to obtain a resistance equal to one whose quotient is 1·8, but which shall have a surface equal to 4, we must give it a length such that $\frac{x}{4}$ shall equal 1·8, or, in fact, a length equal to 1·8 × 4, or 7·2.

In the same way we can substitute for any given resistance an equivalent having a given length, by making its surface such that the quotient of its length divided by its surface, shall be the same as that of the given resistance.

Thus, if we require a resistance whose length shall be 4, having a resistance equal to 1·8, we must give it a surface such that $\frac{4}{x}$ shall equal 1·8, or $\frac{4}{1·8}$ or 2·22.

We can reduce, therefore, any series of different resistances, having different lengths and different surfaces, to equivalent resistances, having *all the same surfaces*, and having therefore lengths which will be proportionate to, and consequently represent, their resistances.* Such has been termed by Ohm, when treating of conductors, their "reduced length," which means nothing more than their resistance, or, in fact, the quotients of their absolute lengths divided by their surfaces.

(To be continued.)

THE INDUCTION COIL.

THE induced currents in the coil machine are of two descriptions, direct and inverse. The first, in the same direction as the battery current, is produced when this current is interrupted, and the core of soft iron loses its magnetism; the second occurs when the primary circuit is completed, and the iron core becomes magnetic. It has been shown by POGGENDORFF that the tension of the induced current in the same direction as that of the battery is very much higher than that of the inverse current. When one of the poles of the secondary wire is brought into contact with the electrometer, the instrument becomes charged sometimes with positive, and sometimes with negative, electricity. But if, instead of bringing the pole into direct contact, we approach it towards the stem of the electrometer until a succession of sparks takes place, we find that the same pole furnishes constantly electricity of the same nature. The experiment succeeds best when the contrary pole is in connection with the earth. The electrometer then becomes charged at a far greater distance, but without the production of a visible spark.

Again, when a galvanometer is interposed in the secondary circuit, when this is interrupted by a small space of air, a deviation is observed in a determinate direction,—that which corresponds with the deflection which would be produced by the primary current. This deviation is *stronger* in proportion to the thickness of the secondary wire, and is more constant when the interruption of the circuit is in rarified air, instead of in the atmosphere.

The cause of the difference in tension of the two induced currents is susceptible of easy and instructive explanation. "The inverse currents," says M. POGGENDORFF, originate at the moment of the completion of the battery circuit. We know that any closed circuit which surrounds, either interiorily or exteriorily, a coil under inductive action, retards this action and diminishes considerably the tension of the induced current. It is for this reason that the tension of the inverse currents is insufficient to overcome the resistance of the small space of air interposed between the secondary terminals. On the other hand, the direct induced currents originate at the moment when the primary circuit is *broken*, and no retarding influence is then opposed to the inductive action."

In order more effecutally to guard against any loss of power in the coil, due to defective insulation of the secondary wire, M. POGGENDORFF divides, longitudinally, the bobbin upon which the wire is coiled into a certain number of compartments separated by a division of insulating material. This division may be effected either before or after winding the primary wire, by sliding over the bobbin a certain number of disks of ebonite or gutta percha, or of baked wood, having a central aperture. The secondary wire is first wound upon one of the terminal compartments in an unequal number of layers, so that when this compartment has received its full complement of wire, the latter may be led to the second compartment, and so on to the other extremity of the coil. It will be seen that the extreme portions of the wire possessing opposite tensions will thus be separated by a considerable space. The secondary wire covered with silk is further insulated by plunging it into a bath of spermaceti or stearic acid, or in a mixture of oil and wax, maintained at a high degree of temperature. M. POGGENDORFF also adopts the system of MM. FABRE and KUNEMANN, in giving to the coil the shape of a *solenoid* or spindle, instead of a cylindrical form; the inductive action of the soft iron core being greater in the middle than at its extremities.

It appears evident that many of the effects of the coil, such as those obtained by connecting the secondary terminals to the coatings of a LEYDEN condenser, would be increased by dispensing altogether with the inverse induced currents, *i. e.*, by momentarily completing the secondary circuit when the battery circuit is closed.

We extract from "Noad's Electricity" the following description of experiments with the LEYDEN condenser:—

"In the year 1853, M. Masson (*Prize Essay*, Haarlem) made a series of experiments by which he proves that a condenser may be charged by the induction coil machine. He placed the two poles of the coil in connexion with the coatings of the condenser, which coatings he at the same time connected with an insulated Lane's discharger, the balls being $\frac{1}{3}$ of an inch apart; he thus obtained a permanent discharge surpassing in intensity that of the direct discharge of the apparatus in a degree proportional to the size of the condenser and the number of the elements of the pile. Grove and Gassiot have since repeated these experiments on a much larger scale (*Phil. Mag.*, Jan. 1855), and with results of a singularly interesting character. When a pint Leyden phial was interposed between the terminals of the secondary coil, the *exterior* pole being connected with the interior of the jar, the noise and brilliancy of the discharges were greatly increased, but no advantage was gained by increasing the number of the cells of the battery; on the contrary, the platinum contact-breaker was thereby rapidly burnt; when, however, a Leyden phial of double the capacity was employed, the brilliancy of the discharge spark was again increased, and on adding more coated surface, a further addition could be made to the battery with a further increase in the effects, and without any injurious action taking place at the contact-breaker. With a powerful apparatus in the possession of Mr. Gassiot, as many as 30 battery cells and 5 square feet of coated surface were used; the effects were very striking—a roar of voluminous discharge 0·6 of an inch long, increased to 1·5 inch when the flame of a spirit lamp was placed between the terminals. 'I have never,' writes Mr. Grove, 'witnessed such a torrent of electrical discharges—the noise could not be borne long without great discomfort. . . . It is very curious to see the *absorption*, so to speak, of the voltaic power by the Leyden battery; when the maximum effect for a given Leyden jar has been passed, the contact-breaker shows by its sparks the unabsorbed induced electricity, which now appears in the primary wire; an additional jar acts as a safety-valve to the contact-breaker, and utilizes the voltaic power, and so on."

THE ATLANTIC TELEGRAPH COMPANY.

WE hail with extreme satisfaction the renewal of the energetic action which characterized the early history of the Atlantic Telegraph Company formed to unite the British and American shores. On Friday last, a numerous and influential deputation, consisting of the Directors and Secretary of the Company, accompanied by numerous Members of Parliament, and others interested in the realization of this important project, waited upon Lord Palmerston, and from the report of this interview, which will be found in another portion of our columns, his lordship appears to have received the deputation with a degree of courtesy and cordiality, which augurs well for the future. Recent events have materially contributed to impress upon the public mind the desirability of an instantaneous means of communication between the Old and New World. The American Government has taken the initiative, and we sincerely trust that our own Government will not be found wanting.

We have now before us several printed documents, illustrative of the advances which have been made in public confidence respecting submarine telegraphs. We pass over the "opinions of the daily press," and place before our readers the opinions of practical men. The Company,

* The nature of the dielectric is assumed, for the present, to be the same.

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it appears, has submitted a specimen of their proposed core to several telegraph engineers and electricians, with a view of ascertaining its capacity of transmission. Mr. Varley, the chief electrician of the Electric and International Telegraph Company states, in reply to a question upon the point, from Mr. Cyrus Field:—

"In answer to your inquiries respecting the specimen of submarine cable returned herewith, and which is stated to contain 510 pounds of copper and 550 pounds of gutta percha per nautical mile, both of the best quality; and also that the distance between Ireland and Newfoundland is 1,640 nautical miles, which, allowing 15 per cent. for slack, will require a cable of 1,886 nautical miles in length; the speed will be four and a quarter words per minute, with the instruments hitherto used.

"I, however, confidently anticipate that with improvements already made, the speed may be very much increased, and that the cable will be found capable of transmitting twelve words per minute between Ireland and Newfoundland. The average length of a word is estimated at five letters."

Professor Wheatstone expresses his opinion that this cable is capable of transmitting at the rate of sixteen words per minute.

Mr. Thomas Allan, another gentleman who has paid considerable attention to the construction and submersion of submarine cables, in reply Mr. Field, states:—

"In reply to your question, the cost of a cable for 2,000 nautical miles, same as the specimen I gave you to-day, will be £200 per nautical mile. Speed of signalling, ten words per minute.

"The foregoing may serve your present purpose; further details hereafter."

The Gutta Percha Company express themselves ready to "guarantee the efficient and satisfactory working of a length of 2,100 miles of insulated telegraph wire as manufactured by themselves and submerged and maintained in that state." Nor is this all, Messrs. Glass and Elliott, who have already laid 3,677 statute miles of cable state "we are willing to do the work, and to stake a large sum upon its successful laying and working."

Such statements are gratifying, inasmuch as they prove that, notwithstanding the heavy and melancholy losses which have occurred, deep sea telegraphy is now by no means either a scientific or a commercial failure.

We might here suggest that there are other telegraph cable manufacturers and contractors whose advice and opinions Mr. Cyrus Field and the Company might have advantageously sought.

It is to be regretted that no reference is made to the description of sheathing proposed. Electricians are now in a position to determine the size of conductor, and the thickness of insulator best adapted for the expeditious transmission of messages, still we are by no means satisfied as to the most effective method of protecting the core in the process of paying out in deep sea, or for its preservation when permanently laid.

It has been urged that the Atlantic Telegraph Company has created and upholds an offensive monopoly utterly incompatible with the spirit of freedom of trade and enterprise.

The following statement, given in evidence before the late Government Telegraph Committee, by Mr. Saward, the company's secretary, will enable our readers to judge for themselves how far the Company deserves so serious an imputation.

"The Atlantic Telegraph Company sprang out of a scheme for shortening the interval of communication between the United States and Europe, which was originated in 1851, by a Mr. Tibbetts of New York, in conjunction with Mr. Frederick N. Gisborne, an English engineer. The inhabitants of St. John's, Newioundland, whose aid was solicited, were influenced by the opportunity offered to them of making their town a port of call for steamers from Europe; and on the representations of Mr. Tibbetts and Mr. Gisborne, an Act of the local legislature was granted in 1852, conferring privileges in money and land upon the company established by those gentlemen under the name of the Newfoundland Electric Telegraph Company. That Company's proposal was to establish land lines of telegraph from St. John's to Cape Ray, in Newfoundland; a submarine line of about 70 miles from Cape Ray, Newfoundland, to Ashpee Bay, Cape Breton; a land line across Cape Breton to the Gut of Canso, and a submarine line of 12 miles across the Gut of Canso to Nova Scotia, where it joined up with the network of telegraphic lines communicating with Canada and the United States. That Company, after executing a portion of their works, failed to fulfil the terms of their Act, and became insolvent and indebted to the amount of £10,000, chiefly due in St. John's, Newfoundland. Their affairs being in that state in 1853, Mr. Gisborne visited New York with a view to ascertain whether assistance could be obtained to carry out the undertaking to which he had devoted a great deal of personal labour and time. He was there introduced to Mr. Cyrus W. Field. It happened that some time previously to this period the idea of establishing a telegraph across the Atlantic had suggested itself to several individual minds, but it had assumed or substance; and Mr. Cyrus Field, though unwilling to apply his means to propping up the falling fortunes of the Newfoundland Electric Telegraph Company by promoting that scheme as an isolated adventure, conceived the notion of obtaining scientific advice upon the subject of a Transatlantic telegraph from his distinguished countrymen, Lieut. Maury and Professor Morse. Their assurances were satisfactory, and the result was, that an agreement was entered into between six American gentlemen, namely, Mr. Cyrus Field, Mr. Dudley Field, Mr. Peter Cooper, Mr. Chandler White, Mr. Moses Taylor, and Mr. Marshall O. Roberts. Those were six American citizens. This agreement was, that if certain specific advantages agreed to amongst themselves could be obtained from the Newfoundland legislature, they would pay the debts of the Newfoundland Electric Company, purchase its property, wind up its affairs, and become subscribers to a new company, to be called the New York, Newfoundland, and London Telegraph Company, the object of which should be to bring London and New York into continuous electric communication. Mr. Cyrus Field and his brother were deputed to go over to Newfoundland to negotiate with the local authorities, and they there, in 1854, obtained an Act of Legislature, which was subsequently confirmed by the Home Government. That Act grants to the American company so established the following privileges, giving them shortly—

"Guarantee of interest on £50,000 of bonds.

"Grant of £5,000 towards construction of roads across the island.

"Fifty years' exclusive right to land cables on the shores of Newfoundland and Labrador.

"Fifty square miles of unoccupied land on the establishment of the inland communication in Newfoundland.

"Fifty more square miles on completion of the telegraphic communication with Europe.

"The company established, as I have described, having executed its works in the island, turned its attention towards extending the telegraph to Europe. It was found impracticable to raise the capital for this part of the undertaking in America; and Mr. Cyrus Field, during one of his early visits to England, associated himself with Mr. John Watkins Brett, one of the projectors of the Dover and Calais line, with a view to the money being raised in England. Mr. Brett, who was then a good deal occupied with other cables, employed Mr. Whitehouse, whom we knew as an electrical experimenter, to investigate for him some electrical facts in connection with the probabilities of success. Mr. Whitehouse, in the course of these experiments, became acquainted with the present Sir Charles Bright, and finally, these four gentlemen, Messrs. Field, Brett, Whitehouse, and Bright, entered into a contract with each other to become joint proprietors of a separate company in England, to carry out the submarine line between Ireland and Newfoundland. Through the medium of Mr. Cyrus W. Field, these projectors in 1856 entered into an agreement with the New York, Newfoundland, and London Telegraph Company, by which they secured to the company about to be started in England the exclusive right of landing cables, acquired by the former company in Newfoundland and elsewhere, subject to conditions as to completion of works, and so on. This was all the Atlantic Telegraph Company acquired by this agreement; they had nothing to do with the other privileges as to guarantee of interest or appropriation of land; they simply acquired the exclusive privileges under conditions as to executing the works."

The four gentlemen above named having acquired the rights and privileges enumerated, disposed of the same unto the English company upon the following terms:—"*No remuneration to be paid until the cable was laid and successfully at work, and further, until the cable so laid had earned* 10 *per cent. of dividend to the shareholders; after the* 10 *per cent. had been earned the projectors were then to have a right to one moiety of all the balance of profit remaining beyond the* 10 *per cent., but after the failure in* 1857, *and intermediately between that time and the attempts in* 1858, *they were after a good deal of discussion induced to compromise their chance for a sum of* £75,000; *to be paid in shares of the company, which shares were not to be disposed of until the cable was laid and successfully at work.*"

In proof that the concessions and valuable privileges are still vested in the Company the following letter from the Attorney General of Newfoundland in reply to Mr. Cyrus Field is adduced.

"*June* 2, 1860.

"In answer to your letter of the 12th ultimo, I beg to say that for the period of fifty years from the 15th day of March, 1854, 'The New York, Newfoundland, and London Telegraph Company' possess the exclusive right to land Submarine Telegraph Cables on the coast of any Island or place within the jurisdiction of Newfoundland. No other person or company can within that period land on any portion of the shore of Hamilton Inlet, on the coast of Labrador, a submarine cable, that Inlet falling within the limits subject to the Newfoundland Government. The jurisdiction of the Government of Newfoundland on the Coast of Labrador, extends from the entrance of Hudson's Straits to a line to be drawn due north and south, from Anse Sablon, on the said coast, to the fifty-second degree of north latitude, and all the islands adjacent, to that portion of the said Coast of Labrador."

We are not, however, informed whether the old arrangements be-

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tween the Company and the projectors still remain in force, or whether they have undergone some modification. As it is believed that the appropriation of a valuable privilege on the part of a few individuals to the exclusion of all others, is not only detrimental to the spirit of public enterprise at large, but to the prospects and welfare of the Atlantic Telegraph Company, we trust that the projectors and the Company will see the necessity of causing such an explanation to be made, as may remove from the public mind an impression which is prejudicial to the realization of a great and glorious project.

RANDOM PAPERS BY A PRACTICAL MAN.

III.—Joints.

By some mischance I omitted to include in my list of solders the most important of all. I refer to *common solder*, which is that usually employed for telegraphic purposes. It is composed of equal parts of lead and tin, and sometimes of zinc and tin. The first has the lower point of fusibility, but the latter has the greater affinity for iron. Both are excellent for the purpose required of them.

Having disposed of the question of soldering, I will now discuss that of jointing, and first with regard to iron wires.

When iron wire is joined up in lengths for ordinary purposes, the common bell-hanger's joint (fig. 1), is almost invariably employed;

Fig. 1.

but it is evident that this is inapplicable to telegraphs, because perfect contact cannot be ensured at the points of jointure A, nor can solder be applied. Hence some modification is essential, and in the first telegraphs erected the joint (fig. 2), was adopted after a very short

Fig. 2.

experience of the bell-hanger's joint. The electrical continuity was ensured by the binding wire (usually No. 16), lapped, as shown, on each side of the loops, and soldered at the extremities. The vibration, to which the wire is constantly subject when erected in the air, was found to act upon the binding wire, and render the joint unsafe, and some further modification was necessary. The bolt and nut were added as shown in figure 3.

Fig. 3.

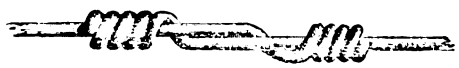
Many thousands of the two above joints are still in existence in different parts of the country, and have caused infinite trouble owing to the destruction of the lapping wire. Great expense has been incurred in renewing and rebinding this small wire. An additional connecting wire has on many lines been added. They are by no means sightly in their appearance, or mechanical in their construction, and they were quickly supplanted by a much more elegant contrivance. These joints were employed almost exclusively prior to 1849, but the removal of Mr. Edwin Clark from the Britannia Bridge to the head of the Engineering Department of the Electric Telegraph Company in that year, led to a series of improvements and alterations, one of the chief among them being the new joint, which, from the above fact was christened, and is still known, as the "Britannia joint" (fig. 4). This is perhaps the most perfect joint that is employed any-

Fig. 4.

where for telegraphic purposes. It possesses all the requisite qualifications of a good joint. Its strength is greater than the wire itself. It ensures perfect electrical continuity. It is indestructible, and therefore suffers no ill effects from the inroads of time. It is easily made, either lying on the ground or suspended in the air, and readily takes the solder. It is now universally adopted in England in the construction of telegraphs. I have never known one of them fail. I cannot say the same of any other joint. The Earl of Caithness endeavoured to dispense with the binding wire, by using a tube or lapping of metal, but experience proved it to be much inferior to the Britannia joint. The tube would not take the solder well, and therefore weakness was the result.

The following joint is a very excellent one, and is frequently employed by the manufacturers in place of welds. It can readily be made in the workshop, but is not easily constructed and soldered on the line. Such joints however frequently break when first strained.

Fig. 5.



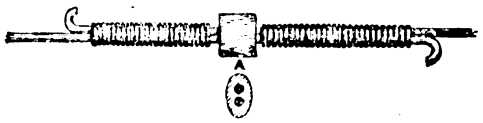
The American twisted joint has been tried by some makers, but its use has been discountenanced from its weakness. I have had to cut out thousands from the carelessness with which they were constructed, and to replace them by the "Britannia."

A somewhat similar joint is employed in France. The French do not use solder.

Fig. 6.

Another peculiar joint of this kind is shown in the next figure, fig. 7.

Fig. 7.



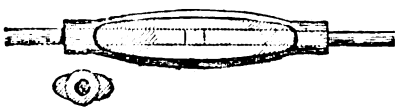
The metal tube A, shown also in section, composed of copper, galvanized iron, or zinc, is pressed by a vice to ensure continuity. These tubes are supposed to facilitate the disconnection of the wire for the purpose of inserting a galvanometer for testing. Neither of these French joints can be said to be perfect, nor to compare with the "Britannia." Twisting the wire weakens it, and displaces the zinc. The point is weaker than the wire, and the absence of solder renders the continuity imperfect. The tube (*serre-fils*), is a clumsy contrivance, and by no means creditable to our ingenious neighbours.

The French twisted joint is much adapted on the continent, but other countries take the precaution of dipping it into a bath of solder.

In Germany and Russia a soldered joint similar to fig. 5 is used.

The following joint is employed by the makers in joining up No. 4, and other large sized wires, which will not easily admit of torsion.

Fig. 8.



The iron tube and butt-joint is heated to redness, and compressed by the hammer before passing through the zinc bath. It is, however, almost impossible to prevent oxidation inside, and weakness is the result. They frequently break.

Mr. G. Preece invented a joint which is applied to larger sized wire sent to India. It is somewhat similar to the last, but the ends of the tube are tapped with a right handed screw at one end, and a left handed at the other, so that by revolving the tube the ends of the wire, made to fit, are brought together. It is a very strong and safe joint. It must, however, be admitted, that of all these joints the most perfect and practical is the "Britannia." It is usually made about three inches long, but for all ordinary purposes; with No. 8 wire, one inch is quite sufficient. Its tensile strength is proportional to the number of lappings of small wire, plus the cohesive force of the solder, and when the sectional area of the sum of the lappings is equal to the sectional area of the wire itself, it is strong enough for all practical purposes.

I will next consider the joints of gutta percha and india rubber covered copper wire.*

* I speak only of the joints that have come under my own experience. There may be many others I have never seen. If I have omitted any worthy of notice, perhaps your correspondents will supply the deficiency. For *acetaycnous* in my last read *autogenous* soldering—a printer's error.

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The Student.

A most perfect form of battery, where convenience and cleanliness, long continued action, and ultimate economy, are of paramount importance, is that of Marié-Davy, a modification of which has been described at p. 86. The positive element of this couple, as at present constructed for telegraph service in France, is a cylinder of unamalgamated zinc, surrounding the porous vessel, which contains the negative element. The latter consists of a cylindrical piece of gas carbon mounted at one extremity with a cap of lead, to which is attached a strip of the same metal, which may be soldered to the zinc element of the following couple in the series. The carbon cylinder is placed in a porous vessel, and surrounded with a paste of *subsulphate of mercury* and water contained in the same vessel. For the benefit of those who may wish to institute a comparative trial of this couple with a Daniell arrangement similarly disposed, we will describe the methods of obtaining the mercury salt and the mode of mounting the battery.

The subsulphate of mercury may be formed by adding dilute sulphuric acid to a solution of nitrate of suboxide of mercury, when the salt is precipitated as a white powder. The subnitrate of mercury is produced by acting upon an excess of mercury with nitric acid in the cold. The solution must not be diluted with water, as it then suffers decomposition, an insoluble basic nitrate and a soluble acid nitrate being formed. The subsulphate of mercury may also be obtained, through a somewhat lengthened process, by gently heating an excess of mercury with concentrated sulphuric acid.

The excess of fluid having been removed from the mercury salt by decantation, the porous vessels may be about half filled with the pasty mass which remains, so that, when the carbon element is inserted, the mercury salt may reach nearly to the top of the porous jar.

The subsulphate of mercury is very sparingly soluble in water. A portion of the salt held in solution passes through the porous vessel and maintains the zinc elements in an amalgamated condition. To hasten the effect of amalgamation a little of the fluid decanted from the mercury salt is generally added to the water placed in the outer vessel with the zinc element.

The action of this battery is precisely similar to that of the Daniell couple. The voltaic action originates in the decomposition of the electrolyte by the zinc, which combines with the oxygen of the fluid. The hydrogen is evolved from the negative element, reducing the sulphate of mercury, precipitating the metal, and setting free the sulphuric acid, which then combines with the oxide of zinc. At the end of a certain period, therefore, metallic mercury is found in the porous vessel, and sulphate of zinc is obtained in solution.

By reason of the low degree of conductivity of the mercury salt, the resistance of the Marie-Davy couple is very considerable, and its quantity therefore in short circuit, is somewhat less than that of the Daniell cell. In tension, however, it is a full third higher than the Daniell, an immense advantage where considerable resistance is to be overcome, as in telegraphic communication. It is obvious that by diminishing the battery resistance we can affect but little the total resistance of a telegraphic circuit, and therefore can add but little to the quantity of electricity traversing this circuit, while by increasing the tension at the battery we may in some cases increase nearly in equal ratio the quantity of the current.

We have had a Marie-Davy conple in constant action for a period of seven months, without alteration, due care being taken to prevent loss of fluid by evaporation. At the end of this time the greater portion of the sulphate of mercury was reduced. By using a considerable amount of this substance in mounting the battery, and by having the zinc element of proportionate weight, there appears to be scarcely any limit to the period during which a couple on this principle could be maintained in constant action This property would render it specially valuable for working electric clocks &c.

THE ATLANTIC TELEGRAPH COMPANY.

The following is a description of a cable just submitted, by Messrs. Glass, Elliot, and Company, to the Atlantic Telegraph Company as the one they would propose to lay, and to a considerable extent to guarantee as to working efficiency, between Ireland and Newfoundland, requiring a length of 1,900 nautical miles.

The electrical conductor is composed of seven copper wires, each one-sixteenth diameter, and laid into a strand rendered perfectly solid by the six outer wires being embedded in Chatterton's compound upon the centre wire. The conductor weighs 510 pounds per nautical mile, and is calculated to transmit (under the *old* system of working) 22 letters, equal to 4½ words per minute, but is certified by Mr. C. F. Varley to be capable of being worked by means of recent improvements at the rate of 60 letters or twelve words per minute between Ireland and Newfoundland.

The conductor is insulated by eight coatings, four of the purest gutta percha and four of Chatterton's compound, laid on in alternate layers, forming together a thickness of three-sixteenths of an inch from the centre; the external diameter of the whole core bring nine-sixteenths of an inch, weighing, with conductor, 1,060 pounds per nautical mile. It is proposed to do away with the tarred hemp, hitherto surrounding telegraph cores and, as a protection to the core, to use strands consisting each of three best charcoal iron wires, guage ·055, each strand being separately covered with Chatterton's compound and gutta percha to prevent decay, these coated strands, 13 in number, are then laid around the core spirally by the usual machinery and the finished cable passed out of the covering machine into tanks filled with water, there to wait till the whole length required is ready for shipment, water tanks will also be provided on board ship, so that from the very infancy of the cable to its final submersion it will be continuously every moment under tests of the most certain and delicate description.

The dispensing with the tarred yarn hitherto in use renders the instant detection of any flaw in the gutta percha core an absolute certainty; these were often temporarily concealed by the wrapping of tar which is, to some extent, an insulator, and only broke out after the cable had been laid and worked through for some short period. Every part of the external surface of the cable being thus also of a nature quite indestructable in, and impervious to, water, there is no fear of deterioration either before or after submersion; and none of the original strength being lost by decaying, it would be possible to lift this cable, if required, even from very deep water.

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.

Fine	2s. to 2s. 3d.	per lb.

India Rubber.

Fine Para	1s. 11d.	per lb.
Negro	1s. 0d. to 1s. 1d.	,,
Java	1s. 4d. to 1s. 5d.	,,

March 26, 1862. Wm. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do. B 7 per cent. till 1862 .	all	18 to 20	———
20	Do. C. ,, ,,	all	9 to 11	———
Stock	Electric Telegraph . .	100	98 to 101	———
10	Mediterranean Extension Tel.	all	4 to 5	———
20	Red Sea and India Telegraph	all	18¾ to 19¼	18⅛—¼
1	Submarine Telegraph, scrip.	all	3/8 to ⅝	———
1	Do. registered . . .	all	3/8 to ⅝	———
10	Do. ,, . . .	all	4 to 6	———
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	———
2	Telegraph to India . .	1	par. ⅛ pm.	1⅛

Telegraphic News.

THE ATLANTIC TELEGRAPH COMPANY.

On the 21st inst., at noon, an influential meeting waited on Lord Palmerston, at Cambridge House, Piccadilly, on the subject of telegraphic communication between Great Britain and the United States. The deputation consisted of the following directors of the Atlantic Telegraph Company, together with many members of Parliament and other

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gentlemen of commercial eminence, whose names are subjoined:—The Right Hon. James Stuart Wortley, chairman of the company; Messrs. C. M. Lampson, George Peabody, Edward Moon, John W. Brett, Cyrus W. Field, and Captain A. F. Hamilton, directors, and Mr. George Saward, secretary; Hon. Algernon Egerton, M.P., Mr. H. Herbert, M.P., Mr. J. C. Ewart, M.P., Hon. Arthur Kinniard, M.P., Mr. A. Turner, M.P., Sir James Elphinstone, M.P., Mr. Dalgleish, M.P., Mr. Buchanan, M.P., Alderman Salomons, M.P., Mr. Samuel Gurney, M.P., Mr. Crum Ewing, M.P., Colonel Vandeleur, M.P., Lord Alfred Churchill, M.P., Mr. Beamish, M.P., Mr. Lefroy, M.P., Mr. W. E. Forster, M.P., The O'Conor Don, M.P., the Hon. Robert Grimston, Mr. Prouse (of Newfoundland), Mr. Alderman Rose, Mr. Ed. Gurney, Mr. Cassell, Mr. Blackburn, Dr. C. J. Wallich, Mr. J. H. Brooking, Mr. Reuter, Mr. Osgood Field, Mr. R. Boden, Mr. W. Evans, the Rev, Dr. King, Mr. Trueman, Mr. T. J. Gibb, Mr. Peter Coats, Mr. H. F. Barclay, Mr. H. E. Gurney, Mr. Samuel Lucas. Mr. H. Ashworth (president of the Manchester Chamber of Commerce), Mr. Schenley, Mr. C. Edwards, Mr. R. A. Glass, Mr. J. G. Barclay, Mr. Elliot, Professor Rogers, of Glasgow, &c.

The Right Hon. STUART WORTLEY, in stating the object of the deputation, said that he understood there had been a communication between the United States through their Minister and also by a special agent, and Her Majesty's Government, in which the former had made certain overtures for co-operating with this country in encouraging the laying down of an electric cable across the Atlantic. It was owing to this circumstance, and also owing to the revival of public interest in this subject, that the deputation had asked leave to wait upon his lordship, in order to ascertain what disposition there would be on the part of the Government to give countenance to such an undertaking. Notwithstanding the partial failure of the late attempt to connect the two continents by means of telegraphic communication, it was generally believed, among practical and scientific men, that the object was perfectly attainable. The company which he represented had been charged, it was true, with a desire to maintain a monopoly; but, so far from that being the case, they had always been ready to place that monopoly in the hands of the Government if they obtained the assistance they required. The importance of telegraphic communication in itself was conceded by every one, and its advantage to the Government was demonstrated by the statements of Governor Sir Edmund Head and other gentlemen, who had every opportunity of knowing the vast saving which a means of speedy communication would effect both to Government and to private individuals. He held in his hand a certificate from the War Office which stated that during the few days in which the Atlantic cable was in operation a message was sent on behalf of the Government, and arrived on the same day at Canada, which had the effect of preventing the unnecessary embarkation of two regiments for India. Unfortunately there was an impression abroad that deep sea telegraphs were a failure, but nothing could be further from the reality. In fact, all the failures which had occurred hitherto had been in comparatively shallow water, and out of twenty-four submarine telegraphs of different lengths, there were twenty-two at the present time in perfect order. The failure of the Atlantic cable arose from circumstances connected with its manufacture and laying down, which subsequent experience had shown the projectors how to avoid. The depth of the sea was also now understood among men of science to be an advantage rather than otherwise. What the deputation wished his lordship in conjunction with Her Majesty's Government to do was, to follow up the last partial success by sending a small expedition for the purpose of taking soundings along the proposed route between Ireland and the coast of Newfoundland—to give a favourable consideration to the overtures made by the American Government—and to guarantee, jointly with that Government, interest at 4 per cent. for thirty years, upon a capital of £700,000—equivalent to a guarantee of £28,000 per annum for thirty years. It was fully believed that the benefits to this country, owing to the stimulus given to trade, would be so vast from the undertaking, that the risk which the Government would have to run would be most wisely incurred. In addition to this they should be glad if a commission were appointed to inquire into the whole subject of submarine telegraphs. Mr. Wortley also stated that Messrs. Glass and Elliot, the manufacturers of submarine cable, had offered to stake a large share of their profits upon the success of the undertaking, provided the cable was laid by them.

Specimens of the cable used in the late attempt, and also others, showing the great superiority in construction of the cable now proposed to be used, were then shown to his lordship, who carefully inspected them.

His LORDSHIP observed that there was no question as to the value of telegraphic communication betwen this country and America, though he feared that unless backed by a Government guarantee the public would not be willing to subscribe their money to the undertaking. If a communication could be established the commercial intercourse would, doubtless, be enormous, and quite sufficient to pay a dividend without any assistance from the Government.

Mr. W. E. FORSTER, M.P., said that if the Government were satisfied, after due consideration, of the feasibility of this or any other project to connect the two continents, he was quite sure that his constituents, as a portion of the tax-paying community, would be of opinion that they would be justified in risking a moderate guarantee in aid of the enterprise.

Lord PALMERSTON: I heard the other day that the American Government had the notion of establishing telegraphic communication with Europe through Asia.

Mr. CYRUS FIELD said that all that had been done was that a committee had reported to Congress, advising the American Government to allow ships to go out for the purpose of making soundings. There were two routes recommended. One was proposed by Colonel Romanoff, and was that the Russian Government should carry the line through Siberia to the mouth of the river Amoor, and thence to the Aleutian Islands. The other was that proposed by Mr. Percy D. Collins, through Behring Straits into Russian America.

A member of the deputation said that the American Government had appropriated £20,000 towards enabling Mr. Collins to make a survey.

Mr. CYRUS FIELD said that the difficulty started against that scheme of Colonel Romanoff was, that the Russian Government had not been able even to march a regiment of soldiers across the route proposed to be taken, so fierce and hostile were the tribes that inhabited the territory.

Mr. STUART WORTLEY said that the distance to be traversed by either line would be between 17,000 and 18,000 miles, and that no less than 4,000 miles of submarine cable would be required, whereas the entire length of the proposed line across the Atlantic was 1,640 miles.

After some further conversation, in which it was stated that the French Government had offered to guarantee a dividend of 10 per cent. upon the capital employed in the construction of a telegraphic line between the coast of France and the island of St. Pierre and Miguelin,

Lord PALMERSTON reiterated his opinion that the subject was one of great importance, and requested that the chairman of the board of directors would forward to him an official statement embodying their proposal. His lordship also promised, on the part of the Government, that such statement should receive impartial consideration.

The deputation then thanked his lordship and withdrew.

VICTORIA.

A SUM of 20,000 pounds has been set down for the extension of the electric telegraph, and the transfer of the existing lines on the roads to the railways.—*Australian and New Zealand Gazette.*

THE UNITED KINGDOM TELEGRAPH COMPANY.

The Bill of the United Kingdom Electric Telegraph Company (Limited), has been before a committee of the Lords for some days past, and after full consideration and hearing the evidence on both sides, their lordships determined (on Tuesday last), to proceed with the bill.

Correspondence.

[We are not answerable for the opinions and statements of our correspondents.]

ATLANTIC TELEGRAPHS.

To the Editor of THE ELECTRICIAN.

SIR,—I beg permission to make a few remarks upon a lecture delivered by Mr. J. E. Davis, R.N., at the Mechanic's Institute, Plymouth, on the 15th instant, on Telegraphic Communication with America, to which you gave publicity in your Journal of last week.

Mr. Davis complains that an American company obtained from the Newfoundland Government the sole right to establish telegraphs from that island and the adjacent coast of Labrador to the United States, and also the concession, to the exclusion of others, of landing wires on the coast. This is true, and the local Act of Parliament, conferring that privilege for 50 years, has been signed and approved at the Colonial Office in London.

But what has Mr. Davis's company done superior to this? They are not Danes, I believe, but so important did they conceive it to obtain some protection for their enterprize, that they have obtained from the Danish Goverment the monopoly of attempting to lay cables on the shores of Greenland, Iceland, and the Faroes during *one hundred* years!! So much for exclusiveness!

Mr. Davis then goes on to make the following remarks:—"Seventy thousand pounds were paid for that permission by the English Company, with a certain royalty to be paid on every message transmitted. There was also a stipulation as to time, so that if we wished to take another cable across now another subsidy would have to be paid to obtain permission to land, and *that* is what brings Mr. Field to this country. He is Chairman of the Company that holds the concession, and is naturally anxious to finger another £70,000 of English money."

Now anything more shamefully mistated than this can hardly be conceived. The misrepresentations are the more unpardonable, as every arrangement of the Atlantic Telegraph Company has been published over and over again, and its history recorded in public documents accessible to every one.

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I will now state the entire connection of Mr. Field with the Atlantic Telegraph Company.

Mr. Davis quietly assumes that the exclusive privileges of the New York and Newfoundland Company were given them by the legislature for nothing. This is a very great mistake. They had to erect all over the inhospitable country of Newfoundland a series of telegraphic communication, to connect that colony with Cape Breton and Nova Scotia by submarine and land lines, and to make roads in certain localities through Newfoundland; and in return for these works, as well as to encourage the Telegraph to Ireland, the exclusive right of landing cables and other privileges were granted.

Having done what they were bound to do on the American side, the New York Company looked at the question of crossing the ocean by telegraph, and they then thought proper to place exclusive rights in the hands of Mr. Field, to be dealt with so as to promote the object of establishing a telegraph from America to Europe in the best manner, he might be able. They allowed him personally at the same time, in consideration of his enormous labour, to retain to himself, or to deal as he thought proper, with any profit that might accrue from the arrangements he might be able to make in respect to the oceanic line.

Mr. Field came to England in 1856. He associated with himself as co-projectors and participators in this assumed profits three Englishmen—Mr. J. W. Brett, Mr. Wildman Whitehouse, and Sir Charles Bright. In due time the Atlantic Telegraph Company was formed. Mr. Cyrus Field, in starting it, took upon his own account 88 shares of £1,000 each: upon all of these he paid into the coffers of the company in cash the first deposit of £17,600, and upon 67 of them he paid the entire amount of calls, amounting to £67,000. This I am in a position to verify. A great number of these have been sold at a loss, but Mr. Field is still the largest holder of shares in the company paid up in cash.

It had originally been arranged that the projectors should receive no remuneration till the shareholders had first been paid 10 per cent. dividend. The directors did not, on reflection, like this arrangement, and wished to compromise it for an amount in shares to be credited as fully paid up. After discussion it was agreed to pay the four projectors £75,000 in these paid up shares, but only *when the cable had been successfully laid!*

When the cable had been laid and worked these shares were issued to Mr. Field and his partners, Mr. Brett, Mr. Whitehouse, and Sir Charles Bright, and I can only say, that from that day to this, Mr. Field has never turned one of those shares into money, nor has he attempted to do so.

But let us here make a little enquiry. Does Mr. Davis, whose propriety is so shocked at the sale of a concession—does he, if he has a projector's share in the Northern route concession—do Messrs. Crosskey and Shaffner and *their* co-partners, intend or desire to *give away* their concession—to offer up their labours and expenditure on the altar of the public good for naught? The Atlantic Company have offered to give up their monopoly to the Government in return for some assistance. Are the Northern party prepared to do the same without personal remuneration? I trow not.

Mr. Davis says that, in addition to the sum of £75,000, which he wrongly assumes to have been paid in cash, a royalty is to be paid on every message transmitted. This is so far from being the truth, that Mr. Field has actually succeeded in making with the American Telegraph Company, an arrangement whereby *they* will make a *reduction in favour* of the Atlantic Company of 40 per cent. of their ordinary tariff upon all European messages passing over their lines.

Mr. Davis says, "that if we wished to take another cable across now another subsidy would have to be paid for permission to land, and that this is what brings Mr. Field to this country, he being anxious to finger another £70,000 of English money." These assertions are totally without the slightest foundation.

Mr. Field has crossed the Atlantic twenty-five times on behalf of the great enterprize to which he has vowed himself; he has laboured more than any other individual in this important cause, and he has never asked the Atlantic Telegraph Company for one shilling remuneration for his valuable services, which he was in no way bound to render them; nay more, when an offer of compensation was made to him he refused it.

The concessions to land cables granted to the Atlantic Company in return for the £75,000 paid-up shares, are, by virtue of that payment, the absolute property of that Company till 1868.

If a cable be laid before that time they will be absolutely theirs till the end of the term of fifty years; and if misfortune prevent the Company from succeeding before 1868 expires there is not a doubt but it will be renewed gratuitously for as long as may be needful.

I pass by the greater part of the remainder of Mr, Davis's lecture merely observing that his electrical disquisition upon Mr. Hearder's cable is not very valuable.

I also pass by his remarks upon the Greenland route, because, while they are intended by Mr. Davis to be laudatory of that route, he is evidently reasoning wrong from right premises, the facts cited by him, and founded on his experience, being its strongest condemnation, and leading to the inevitable conclusion, that to attempt to lay cables along the line advocated by Mr. Davis, would be a highly impolitic expenditure of capital.

I now come to Mr. Davis's statement, that the route of the Atlantic Company will never pay. Upon this point, I forward you herewith the certificate of Mr. Allan, who undertakes that his cable will work between Ireland and Newfoundland at the rate of ten words per minute: of Mr. Varley, that a cable containing 510 lbs. of copper and 550 lbs. of gutta percha per knot, will work at twelve words per minute between the same places; and of Mr. Fleeming Jenkin, that such a cable will work at the rate of eight words per minute. I have also seen a statement from Professor Wheatstone, that a cable submitted to him, costing much less than the preceding, would work across the Atlantic at the rate of sixteen words per minute. Mr. Davis says, that messages can be sent nine times quicker by the Arctic route than by that between Newfoundland and Ireland. Does he mean to say that his Greenland cables will transmit 144 words per minute? If so, they will do six times more work than any aerial line of which I have had experience during the 12 years I have had to do with telegraphs.

Mr. Davis garbles an undertaking given to the Atlantic Company by the Gutta Percha Company whose business has nothing whatever to do with *laying* cables—but who say, if the contractor into whose hands their work passes after they have turned it out perfect, will lay the line in as good a state as they deliver it to him, they will be answerable for its working; but Mr. Davis omits to quote from the undertaking of Glass and Co., the very contractors who offer to lay the cable, who say, that so satisfied are they of its practicability and commercial value, that they are willing to risk a very considerable sum upon that event.

Mr. Davis says that "contractors are to be found to take the responsibility of laying and working the Northern line, and that at a less cost than the direct route." Will he kindly favour the public with their names, that their experience and responsibility may be fairly judged of?

In conclusion, I will merely remark, that if the interests of the Northern route can only be advanced by garbled quotations and coarse personal calumny, it has but poor props to rest upon.

Yours, George Saward.

[Our article under the heading, "Atlantic Telegraph Company," was in type before Mr. Saward's letter was received.—Ed. E.]

To the Editor of The Electrician.

Sir,—Accident has brought under my notice here the letter of "Au Revoir," in your number of the 24th January, which appears to require some reply. In speaking of the laws of the attractive force between electrified bodies, which is well known to increase as the square of the quantity of electricity, or putting the same fact in another view, as the square of the tension or electromotive force of the electricity, he quotes an opinion I had given to the effect that this duplicate ratio was due to the conjoint influence of the quantity and the tension, and not to the simple influence of either of these functions taken separately. He adds: "This, to my mind, is not very lucid; two *when* added to two, certainly make four; but does not Mr. Clark perceive that the doubled tension would, according to his view of simple proportion, be the full effect of doubling the number of particles, so that his afterwards adding one doubling to another is vicious! It is to be regretted that he did not advance the reasoning another step and calculate *three* measures of quantity, for his error would thus have been made obvious. We may now do it for him:—*One measure of electricity upon an insulated conductor exerts a certain attraction upon a neighbouring body; if we add a second and a third measure the attraction is increased nine times. Three parts of this force are due to the increase of tension, which is trebled; and then to the increased number of particles in action, which is also trebled.* But three added to three are only six, and not nine, as required by the argument, which will not inadvertently slip, like the reasoner, from addition into multiplication; it so happens that $2\times2=2+2$, but with higher numbers it is not so," &c.

"Au Revoir," in common with many of your readers, has probably perceived before this the arithmetical fallacy into which he has fallen, but lest it may have escaped his notice, it may be as well to point out that if *two* particles of electricity, each exerting an attraction of *two* pounds, pull with a united force of four pounds, just in the same manner do *three* particles, exerting on attraction of *three* pounds, pull with a united force of nine pounds; and similarly do *ten* particles, each pulling with a force of *ten* pounds, exert a united attraction of a hundred pounds, which is in accord-

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ance with the acknowledged facts of the case and the theory advanced upon them. That gentleman is also misinformed in supposing that I make a distinction between *electrical tension and electrical intensity;* I know of no difference, but I have observed that the word intensity is often applied to cases in which it is only partially the operating cause, and is used by different persons to express very different ideas, and I have therefore discarded it altogether, employing in its stead the term *tension*, which has long been in use both by English and continental writers, and has no ambiguity of meaning; many, however, still prefer to use the term *electro-motive force*, or *potential*. LATIMER CLARK.

Suez, March 8th, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—I am much indebted for your article on the use of iron for a positive metal in the voltaic arrangement, which, I think, will be the means of setting amateurs and myself right in this matter, and I trust that such *practical* articles will often appear, for by such means as are usually given under the head of "Student," more practical knowledge is gained than reading through volumes of theories, though I admit it is necessary that the student should have some knowledge of the theory of the science. Your remarks as to the quantity of electricity developed by the use of iron, leads me to think that it seems well suited for experiments with a coil, the circuit of the primary wire offering but very little resistance, and as *quantity* is essential for the production of magnetism upon which the power of the coil depends.

Is the electric light dependent for its source on quantity or intensity? if the former, it may be used economically for its production. A good experiment suggests itself to test the power of iron over zinc in the production of magnetism, by immersing one plate of iron of any convenient dimensions, and a plate of zinc exposing the same surface, and of the same weight, in acid solution of the same strength, two electro-magnets coiled each with the same length of wire, and then allowing the current of each battery to pass through the wires of each separate magnet, and testing the amount of weight that each electro-magnet will sustain, allowing the batteries to work until they cease, taking note of which remains in action the longest, and likewise the waste of metal. I promised to give a description of a contact breaker for a magneto machine, but I think you will smile, as it aims at an impossibility, viz., the production of perpetual motion. I have not tried the experiment, but I wish you to set me right on the question, as it appears to me very feasible. I propose to have a strong horse-shoe magnet fixed with its poles upwards on a stand, having previously been wound with covered copper wire very stout, say about No. 12, for the production of a *quantity* current; on the same board is fixed a piece of soft iron of the same form as the magnet, but about one inch less in length, and fitted about one foot or eighteen inches from it, standing opposite to the magnet in a parallel direction, and standing upright, the same as the magnet; around this is to be wound several layers in continuation of the wire from the magnet, and the ends brought out to binding screws, upon contact being made and broken with the magnet by an armature, an induced current will circulate through the wires, causing, as I imagine, the *iron* horse-shoe to become for an instant a magnet to draw down the long arm of a lever, to which is attached a piece of iron; the *iron* magnet being deprived of its magnetism, the armature of the permanent magnet is again attracted and causes another current, and so on *ad infinitum*. If the description is not made apparent to you, I have sent you a rough sketch. Will you give me your opinion of it, and if it will not not act, why?—Yours obediently, J. COOK.

[Both quantity and tension are required for the electric light. A Maynooth cell of moderate size will afford sufficient quantity, and between 40 and 50 alternations of this couple will give sufficient tension. Making and breaking contact with the armature of a permanent magnet will *not give an induced current*. If in lieu of a permanent magnet you had a horse-shoe of soft iron, and a permanent magnet for the armature, you would obtain an induced current; but, we fear, no further result. We may shortly have occasion to describe one or two electro-motors.—ED. E.]

INDUCTIVE RESISTANCE.

To the Editor of THE ELECTRICIAN.

SIR,—May I be permitted to refer Mr. Webb to that portion of his paper in your 17th number (page 197), where, in elucidating his conception of resistances to induction, he says that a Leyden jar at the prime conductor of an electrical machine is susceptible of twice the quantity of charge when the rubber is uninsulated, than when it communicates only with the interior coating of a second similar jar; and to ask, whether he gives that as the actual result of experiment, or only as *what should be* assuming his conception of resistance to be true.

Because, if it be given as a fact, I shall much desire to verify it, as at present it is opposed to my convictions; indeed under any circumstances it will be worth while to consult the experiment, for it is perhaps the best that could be devised for determining whether halving the inductive circuit does or does not halve the resistance opposed by nature to the induction; and thus either for corroborating Mr. Webb's theory, or proving it to be imaginary.

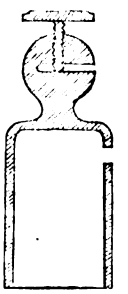
Mr. Webb is evidently so earnestly in pursuit of electrical knowledge, and his arguments are so clear and conclusive generally, that every one would regret to find they had not the advantage of a true basis to start from. AU REVOIR.

NITRIC ACID BATTERIES.

To the Editor of THE ELECTRICIAN.

SIR,—Having amongst other matters devoted some portion of my leisure hours to the study of electricity, I have long felt desirous of applying it as a motive power on a small scale, and with as great an amount of economy as is practicable. For this purpose I constructed three cells of "Smee's" arrangement, exposing a little over a square foot of zinc to dilute sulphuric acid of one to eight. Finding the quantity of electricity too small for my purposes, I then made two cells of the "Daniell's," six inches deep by four inches diameter of copper, the zinc cylinder being one inch diameter. Combining these with the Smee's for quantity the results were tolerably favourable, but far short of my anticipations, and much more so of my desires. At this stage of my experimenting a friend lent me a small "Maynooth battery"—a combination of which I had previously read, but had never seen, and I was truly astonished to find my five cells so completely thrown into the shade by the immense quantity (in comparison with size) given off by this single cell. I had, however, barely cried, "Eureka," with the ardour of a successful novice, before I found out the serious objections to the "Maynooth." In the first place, cast iron, though remarkably "passive" to nitro-sulphuric acid, does still oxydize under its influence, and the iron cell is extremely liable to become "riddled" at the bottom, and I need not remark upon the "beneficial" effects of the exuding acid upon surrounding objects such as table covers, books, &c. that may be in the vicinity during the experiments. Secondly, the nitrous acid fumes, which, I apprehend, are not only offensive, but extremely deleterious when inhaled, do not confine themselves to the lungs of the experimenter, but attacking every polished iron article in the room, leave a tolerably deep impression of their presence in red characters behind them.

In consequence of these objections I was on the point of giving up the "Maynooth," but on reading the description given of "A Student's Battery" in your fourth number, pp. 42, 43, the idea struck me that I might reverse the "Maynooth" arrangement, as you there do the Daniell's, and by thus confining the nitro-sulphuric acid in an earthenware vessel totally obviate the first and greatest objection to the use of this form of battery, the other I hope to master by covering the cells with a perforated disc, on which quicklime is placed in lumps. I accordingly obtained a set of Mr. Jupp's cells, as advertised in your columns, the jars being of brown earthenware, and the porous cells of plaster of paris. I placed the zinc cylinder soldered together in the outer jars, and had six iron "nine-pins" cast, as shown in section, through the heads of which I drilled holes and inserted binding screws, so that one copper wire would connect the lot, or as many as might be desired for "quantity arrangement." By this means it will be seen that a large surface of cast iron is



exposed to the acid, sufficient, in fact, to act as a perfect negative to the zinc cylinder, while the cost of one cast iron Maynooth cell would cover that of two dozen of the "nine-pins," the whole battery remaining small in dimensions and unique.

This simple combination attached to a medical induction coil gives shocks that I do not think any human being could receive with impunity, judging of its effect when the electro-magnet is almost insulated, and it also accomplishes that which I was previously unable to attain, it gives motion to both the models of electro-magnetic engines that I had constructed.

In the absence of any better meter I have hitherto used the "induction coil" above referred to as a "galvanometer," judging of the respective merits of different batteries by the shock produced, this, however, I am perfectly aware, is a very crude and unreliable test, hence I very gladly availed myself of the directions given in your fifth number for the construction of a galvanometer, and made one to pattern, but found it was an extremely sensitive instrument, and as a resistance coil of a few thousand yards of copper wire is rather expensive, while water is a good non-conductor, I imagined that a glass tube filled with water would form a good "resistance coil." I therefore fitted a brass cup to the end of a tube six inches long and half an inch bore, the cap screwing into the board upon which the galvanometer is placed, and the tube fastened in with hard cement, it is then filled with water and a cork inserted, through which the other battery terminal passes freely. The tube being graduated either in inches or degrees by raising or depressing the terminal, which will act as an index, the relative measure of any battery arrangement can readily be estimated.

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"Blown about by every wind of doctrine," I have tried Mr. Cooke's wrought iron positive, but so far without satisfactory results, I used a cylinder of stove piping and a graphite negative, and afterwards one of my cast iron "nine-pins," for a negative, but did not succeed. I obtained a fair quantity for a very short time, but it soon became nil! leaving the positive perfectly crusted with crystals, for which I want a name, and the nitro-sulphuric acid became a dark thick compound of ——, I can scarcely trust my chemical knowledge to say what.

Fortunately, however, for science in general, and Mr. Cook's views of it in particular, there is no necessity for despair, since your correspondent from Bath, "H. T.," suggests that a process which decarbonizes *cast* iron, making it partially malleable, will with equal facility decarbonize malleable iron, rendering it ultra-malleable, *i. e.*, electro-positive. Carbon being the "root of all evil" in iron batteries the process of revolution thus becomes magnificently easy.

You have had many correspondents since I first began to con your paper, and as various have been their proclivities, but "H. T." is decidedly the primordial inventor of eliciting the "electric light" from a bottle of "high pressure smoke," what a brilliant corruscation must emanate from the instantaneous incandescence of a tremendous shower of carbon particles! if such were the conditions required?

Finally, it looks very like "drawing out leviathan with a hook," when we catch whales by Ruhmkorff's coils: would it not be better to do as the boys do with birds, wait till we can put a little salt on their tails, and thus produce æsthesia by hydrochloric-hyacidizing them? This would certainly be preferable, if possible, to "H. T.'s" suggestion, as the coil named is very expensive, and would naturally add to the cost of "train" oil—a very serious consideration at the present moment, when we contemplate "street railways" as becoming a permanent institution.—I am, sir, yours respectfully, K. R. U.

March 24th, 1862.

[The amount of the surface of the electrodes in the water resistance *meter* should remain constant. The wires, or one of them, with the exception of the terminal surface, should therefore be varnished, or otherwise protected. The residues of the nitric acid battery with the iron positive, are sulphate of iron, a nitrate of the metal obtained with difficulty in the forms of crystals, and the nitrate of ammonia.—Ed. E.]

SCIENTIFIC TERMS.

To the Editor of The Electrician.

Sir,—Could you kindly inform me through The Electrician which you consider the best dictionary for scientific words? I have searched several dictionaries, but cannot find the words occurring in your journal.

Enquirer.

[Hobling's "Scientific Terms" is, we believe, considered a good work of the kind you mention. It is published by Whittaker, Ave Maria Lane. "Mayne's Lexicon" (Churchill) is expensive, but is favourably spoken of by those who have occasion for its use. If you will forward a list of terms we may be able to give the information you require.—Ed. E.]

To the Editor of The Electrician.

Sir,—I have been engraving a small map of the Mediterranean, on which I have laid down the course of the submarine telegraph cables, but find extreme difficulty in learning whether some of them are in working order, or whether broken or interrupted, and I have been advised to apply to you as being likely to be able to give me the information required. If you can, and will kindly do this, I shall feel much obliged to you. The cables of which I am much in doubt are those from Syra to Candia, Athens, Scid and Smyrna, and to the Dardanelles. One from Oporto to Avellona (on the mainland north of Corfu), and those from Spain to the Bolearic Islands. That from Barcelona to Port Mahon, I am told, is broken, and the one from Kaven (near Cape St. Antonio) to Irica was believed to be interrupted. There is also a large Prussian map at the office of the International Telegraph Company, supposed to contain the best information. A cable from the northern extremity of the Bosphorus to Varna, but as there could be a communication between these points by land, what this can be for I cannot imagine, and I cannot hear if it is working, or anything about it.

Apologizing for giving you this trouble, being a stranger to you,—I remain your obedient servant, J. W. Lowry.

March 20th, 1862.

[The cable between Syra and Candia is *broken down*, and the cables between Athens, Scio, and Smyrna we believe are *broken down*, as well as that to the Dardanelles. The state of the cable between Oporto and Avellona is doubtful. The line from the northern extremity of the Bosphorus to Varna, a portion of the famous Balaklava wire, has broken down long ago.—Ed. E.]

TELEGRAPHIC LINE.

To the Editor of The Electrician.

Dear Sir,—Will you kindly inform me what the dimensions of the plates, and what number of cells of the Smee's arrangement of battery would be required for an electro-magnet, under the following circumstances? A well insulated (gutta percha covered) copper wire, No. 20 guage, is laid in an iron pipe underground through a distance of 250 yards, and then after traversing two electro-magnets (above ground) ⅛ths of an inch diameter, terminates at each end in an earth plate of copper, 18 inches square and 4 feet deep in a loamy and wet clay soil respectively, with an interval of 200 yards between them.

I shall be most thankful for this information from yourself or any of your readers.—Yours truly, L. L. S.

[The length and diameter of the wire coiled upon the magnets should be stated. Perhaps some of our correspondents may possess a practical knowledge of the character as a telegraphic "earth" of the description of soil mentioned.—Ed. E.]

Miscellanea.

Voltaic Battery.—We have seen a very convenient form of Callan's cast-iron battery, designed by Mr. H. Turton, which is more especially intended for lecturers who wish to exhibit the electric light, &c. The exciting fluid in this battery is a mixture of sulphuric acid with a solution of common salt, possessing considerable advantage, in point of economy, over that employed in the Maynooth battery, viz.: dilute sulphuric acid for the positive and nitric acid for the cast iron negative. We propose next week to give an illustration and some further description of this arrangement, which may be of interest to many of our readers.

Manganate of Soda.—A crucible is filled with a mixture of equal parts of powdered peroxide of manganese and crude nitrate of soda, and exposed to the temperature of a pottery furnace during the time occupied by one baking; upon cooling, it contains a fused black mass. This mass, powdered and extracted with boiling water, leaves a residue having the appearance of hydrated peroxide of iron. The liquid, filtered through fragments of glass and allowed to cool, partially solidifies to a mass of almost colourless crystals, having the acicular form of sulphate of soda, and containing

$$NaO,MnO_3+10HO.$$

When dissolved in water, they partially decompose, forming a green solution. The crystals can only be dried on bricks or porous porcelain; they immediately decompose in the presence of organic matter.—*Journal fur Praktische Chemie*, lxxxii., 58.

Mercury.—An easy method of purifying the metal when oxidized, or accidentally or purposely contaminated with lead or tin, is to shake it up in a bottle with a few drops of nitric acid. It may then be poured into a vessel of water to remove the soluble nitrates, and filtered by forcing it through chamois leather. When nitrate of mercury is required for amalgamating the ends of the battery terminals, &c. to ensure perfect contacts, it may be made by pouring a little nitric acid into a phial containing a small quantity of the metal. It is best that the whole of the mercury should not be dissolved. The end of a wire may then be amalgamated by dipping into the acid solution, and subsequently bringing it in contact with the fluid metal beneath. Zinc elements may be amalgamated by immersion in the nitrate solution of mercury, but we have found the following method preferable:—A small quantity of mercury is placed in a plate or saucer, and covered with dilute sulphuric acid. The zinc elements are then brought into contact with the mercury, which, with the acid, may be rubbed over the surface with a small brush, such as a tooth brush. The zinc cylinders used with the common Daniell battery may be maintained in a proper condition of amalgamation by pouring a little mercury into the porous vessel containing the element.

To Correspondents.

C. L. M.—(The Atlantic Telegraph Company.)—The expenses of the electrical department alone exceeded the enormous sum of £16,000, and that of the engineers' department, £22,000, while we are informed by the secretary of the company, in his evidence, that he considered the primary cause of failure to be the great hurry and too little preliminary experiment. The total expenses of the Experimental Committee, appointed by the Board of Trade, did not exceed £2,500; nevertheless, results were obtained which cannot fail to be of the greatest advantage to the science of deep sea telegraphy. Notwithstanding the large amount expended by the company for electrical purposes, the secretary in his evidence, complains of the "defective arrangements of the chief of the electrical department," who himself was one of the four projectors, entitled to a portion of the £75,000, to be paid for certain privileges. Mr. Walker and Mr. Whitehouse, we believe, were in favour of even a considerably smaller conductor than that adopted for the Atlantic cable. Subsequent experiments have, however, conclusively determined the question in favour of the advocates of a large conductor.

An Inquirer.—The two connecting screws you refer to are probably those for connecting or detaching the condenser in the primary circuit. We cannot understand why the break becomes inefficient when the conductor is attached, unless it be through some fault in the construction. Can you give further particulars?

Momus.—Crowded out this week.

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The Electrician.

Vol. I. No. 22.—April 4, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 243]

135. We have now to pass through a part of our subject that constrains us to be somewhat controversial. By a few simple demonstrations our pages have shewn, for the first time on mechanical principles, how static electrical induction becomes set up, and how it produces the visible phenomena of attractions and repulsions; and we have been enabled to do this by virtue of—first, a limited electrical attraction (which forcibly reminds us of the now-established, and all-important, doctrine of *equivalents* in the sister science of chemistry); and, secondly, a law of that attraction in which our experiments on quantity imperatively require us to believe, though it implies that the force itself is not amenable for its origin to the axiomatic equality, which, from first to last, it establishes through an unbroken chain of physical causes and effects.

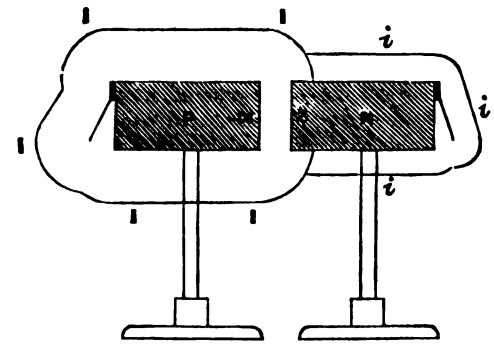
136. And what did we find in the place of these simple and effective doctrines? We found an unlimited electrical attraction that could afford us no satisfactory insight whatever into the nature of static electrical induction, with its accompanying attractions and repulsions; and, to govern that force, we found an axiomatic law, which it practically sets so much at defiance as to need unheard-of contrivances for reducing it to consistency; for it has been assumed lately, by way of helping it, that electrical forces can be "reflected," or "reverberated," and thus made to be of any magnitude that the facts of any case may require. If that conception of reflected forces mean anything it must be this: as A is attracting B with a force equal, say to 20, so B is attracting A with a force equal to 20; but, in addition to this, B reflects, or reverberates, some part of the 20, which is reciprocal between itself and A back again, whence it came, the force so reflected added to the original one constituting a sum total that must be taken to represent the effective amount of the attraction.

137. If there be any such reflections of physical force in nature, we have hitherto escaped the ill-fortune of meeting with them, or the faculties we may happen to possess for investigating causation must have succumbed to the difficulties they would have presented! Let us see by what facts reflected electrical force is said to be indicated. For that purpose we cannot do better than revert to our figure 22, placing it again before us, and also the two cylinders charged as before; P with plus electricity communicated to it, and N with a charge propagated by induction across the interval from x to z: each of the charges being denoted by the inductive atmosphere traced around the particular cylinder to which it belongs.

Exp. 22. Things being as above described, put N into conducting communication with the ground, which may be done by touching it with the finger or an uninsulated wire. Thereupon the metallic leaf of P will in great measure cease to diverge, while the collapse in the case of N will be complete.

138. We will first explain these occurrences on our own principles, and then bring into contrast with them the conception of reflected forces. We have already said that a portion of the natural electricity of N lying about z, that is, most contiguous to the plus charge in P, being dismissed from the attraction of its own common matter, dispersed itself over the outer parts of N's surface to find greater facility of induction, by which the intensity of its action might become reduced. It is hardly necessary

Fig. 22.



to say that if N had exposed to the air a much larger surface, the distribution of the induced charge would have been proportionately more extensive, and the reduction of intensity more perfect. Now, what we do by the uninsulation of N is, not to extend its surface, but something else that is tantamount to so doing, for we bring that surface into conducting communication with the earth, which, as a conductor surrounded by an inductive atmosphere, would be of infinite effect in reducing the intensity of the charge by diffusion, even if it had not other means of disposing of it, that we can easily conceive, but need not now step aside to consider.

139. By connecting N with the earth, we therefore provide an outlet by which some of its natural electricity, set free by induction, departs from it; thereupon, neither N nor the metallic leaf against its face, wants any longer an inductive atmosphere, and collapse is the consequence. So soon as the induced charge has departed from N, the plus electricity in P collects about its face x, because its inductive action in the direction, $x\,z$, has ceased to be so much opposed by reaction; in order to collect thus, it leaves, of course, the cylindrical parts of P, as well as its external face, in quantity proportionate to the proximity of the uninsulated conductor, causing the divergence of the metallic leaf of P to diminish for want of sufficient electrical attraction to oppose to its gravity.

140. On the supposition of the foregoing explanation being true, it should follow that if we enlarge the conducting surfaces in communication with N in any other way than by connecting it to the earth—as, for example, by making it communicate with several insulated conductors, or with one of sufficient surface and freedom of exposure to the air, the collapse of the two metallic leaves will ensue just the same, only perhaps to a lesser degree, corresponding to the difference of surface from which the inductive action would then have to be propagated; and this result is precisely that which we actually obtain in practice.

141. The thought comes over us while we are writing, that the student in electricity who is perhaps now meeting with these facts for the first time, and simultaneously with an explicatory theory on mechanical principles, may wonder what there is in them ever to have created the least difficulty; but he may judge whether they have been comprehended or not by what we have told him about the reflected forces thought necessary for their theoretical explanation. He may be able to decipher them down to their minutest particulars; but then he has never been perplexed by viewing the electrical force as susceptible of being multiplied an indefinite number of times after the manner of images reflected between opposite mirrors.

142. Some philosophers in physics evince a disposition to

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ignore as far as they can, the existence of everything but the forces which are found operating upon matter, with the intention it is said, of keeping their ideas of causation as simple as possible; and the conception was a few years ago made so poetical as to represent all the forces and some things beside, as naturally convertible into one another. We concede to poets great licence, and may not object to a metrical, or even a prose composition having for its subject the rebounding propensities or the disposition to transmutation of the electrical forces; but we must at times, when we are not poetical, continue to discredit the growth of electrical attraction out of itself, or the multiplication of its force on the principle of reflections.

143. But if for the sake of argument, we were to admit the doctrine of "reflected" or "reverberated" electrical forces, our toleration of it would be destined to come to a speedy end, for it does not comply with its own requirements. We should be obliged to set out with admitting that the "reflections" must of necessity increase in the simple ratio of their physical cause, that is to say the original electrical force; but while the latter increases as the series 1, 2, 3, 4 and so on, we should require the reflected force to increase as the series 1, 2, 6, 12 &c., for otherwise the force and its reflections when added together would not give us the series 1, 4, 9 and 16, as is required by the very facts which have been thought to shew a necessity for, and thus to prove the existence of, those reflections. Are we to go so far as to fancy that the original force, or parts of it, are reflected just that precise number of times that the necessities of any particular case may require?

144. And yet the electrician with whom the suggestion originated, thinks—to use the language of one deputed to publish his meaning—that "the time is fast approaching when it may be found desirable to treat this species of force (electricity) as Newton did Gravity." We, too, believe it will soon be so treated; but if it be, the mathematical process must not be founded upon "reflected" forces, or it will not be assimilated to the theory of gravitation. Newton's system is remarkable for the simplicity of its principles, but had it needed that gravity should be increased in force by its own action, or be reflected back again from one body to another; that great man would have done as well to have left astronomers floundering in the vortices where he found them, for few would have been able, or willing, to follow him through such complications of mechanism.

145. And what confusion is there not at the basis proposed for a new mathematical theory of electricity! We will quote it as it has been published:—Static induction "depends first upon the direct influence of the electrified surfaces, secondly upon a reflected induction thrown back upon the excited (charged) body. The total force is a compound ratio of these forces, and it is in this way we obtain a force in the inverse duplicate ratio of the distances." "Other laws of force are still possible, and by no means improbable, under other laws of augmentation in the reverberatory or inductive actions." "In this way we might obtain laws of force as the fourth or any other power of the distance inversely, did such laws exist." "In the reciprocal action between a charged and neutral conductor, reflections of force are produced within the opposed surfaces, which reflections are perpetuated *ad infinitum*, much in the way of optical reflections between two mirrors." "This understood, we will proceed to consider the laws and operation of these direct and reflected inductive forces." The student of electricity under the old systems has long encountered at the very threshhold of his science an unnecessary Babel of confusion! First, forces that have no existence, and which, therefore it has been impossible for him to gain any satisfactory knowledge of, and then technical terms, unsettled in definition—received by some, repudiated by others—and withal so learned and numerous that he might well hesitate to attempt their mastery. Is he now in addition to all this evil to be turned back in despair by finding the portal barred by a new complication, the investigation of which none but the best mathematicians could even attempt and from which we dare not hope that even they would be able to deduce anything satisfactory? Forbid it Genius of Progress!

146. Among the practical information published by the author to whom we are chiefly alluding, and whose experiments generally are made with much care and exactitude, we find a statement which we feel bound to notice, because if it were correct it would make known a fact that our theory would not be competent to explain—the only one, so far as we know, having that exceptional character. It is said that the outer face of the cylinder N (under the circumstances figured in our diagrams, figs. 21 and 22, but with N in conducting communication with the ground "may become under *some conditions* quite neutral, and evince even an opposite or negative state." The two words in italics may embrace much under which the statement in question may be true; but if nothing virtually alter the bearings of the case as we have put it, if the conditions be as they are described in the words of the writer himself, and fairly expressed by those we have used, then we do not hesitate to say it is utterly impossible for the outer face of the cylinder N to become negatively electrical. Neutral it will be, not sometimes only, but always. Our theory points out how the mistake may have arisen; for if N be temporarily uninsulated while at a given distance from P, and that distance be *afterwards* slightly increased, a negative condition at the outer face of N would be a result; or, which is more likely to occur, the same negative condition may in time become set up in N, if, inadvertently, P be suffered to lose a portion of its plus charge by default of a proper insulating atmosphere.

147. Having said thus much, which, we think, the interests of electricity in general, and those of the student in particular, demanded, we turn from the unpleasant task of differing from our respected contemporaries to pursue our own particular doctrines. We shall now want three insulated conductors; we will, therefore use with our two cylinders one of the wooden balls (par. 35), with which we formerly experimented.

Exp. 23. Communicate to each of the two cylinders a direct electrical charge, that of P being plus, and that of N minus, the two being as nearly as they can be made equal to one another. This may be achieved with sufficient accuracy by placing them for a moment in contact, respectively, with the opposite conductors of the revolving machine only slightly charged, and afterwards equalizing the divergence of the two metallic leaves by removing from the cylinder in which the divergence is greatest, successive small portions of charge, by means of the brass ball, (83) or proof plane used in this case as an insulated carrier, discharging it, of course, after each contact.

Now, if we act upon either of the charged cylinders in the absence of the other, by presenting to its plain face the insulated ball, we shall have under similar circumstances analogous visible results to those we before obtained by presenting N to P; simply because common matter attracts electricity by virtue of the same force, and in conformity to the same laws, that are active when electricity is attracting common matter, and the only theoretical distinction between the two cases will be this: when the plus charge is acting inductively, the common matter of the surrounding air will be made inducteous and its electricity inductive; on the contrary, if a minus charge be acting inductively the common matter of the surrounding air will be made inductive, and its electricity inducteous; but these are not differences that will affect any of the conclusions we shall now have to consider. We need not experimentally go over the same ground again, but proceed at once to use the two charged cylinders at one and the same time. Stand them in a line with their plain faces parallel to one another, and about nine or ten inches apart, and having placed the insulated conducting sphere midway between them, push them forward with equal rapidity, and leave them at rest at a short distance from its surface, the distance on the two sides being the same as nearly as possible. Now uninsulate the sphere: on doing so the divergence of the metallic leaves, which grew less

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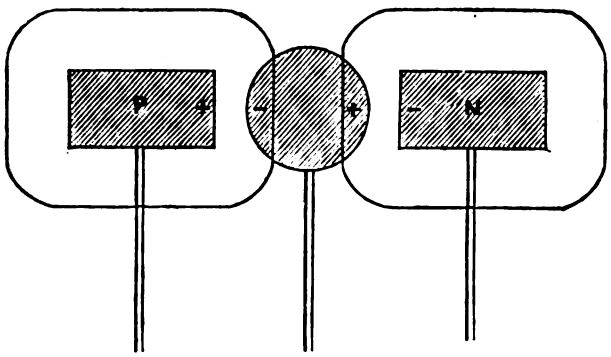
as the distance was being diminished, will not be further affected, denoting that, although the sphere was in possession of two electrical charges, neither of them escaped into the earth by the uninsulation. To prove this, remove either cylinder, when it may be ascertained by applying the proper test, that the part of the sphere to which it had been presented is oppositely electrical; if both the cylinders be removed, every portion of the sphere, assuming the experiment to have been well conducted, will be found neutral. Our theory of the experiment is, that the sphere in its midway position between the two oppositely and equally charged cylinders, neither had nor required an inductive atmosphere, the plus electricity virtually and actually liberated by the induction on one of its sides passing over to the other, where by induction it was wanted. The following figure may serve to illustrate this and fix it in memory.

Fig. 24.



(To be continued.)

ATLANTIC TELEGRAPH COMPANY.

On the 26th ult., a *conversazione* on the important subject of uniting America and England by means of the electric telegraph between Ireland and Newfoundland, took place at the town residence of Mr. Samuel Gurney, M.P., Prince's Gate, Hyde Park. A numerous attendance testified to the interest with which the question is regarded in political, commercial, and scientific circles, and amongst the company we noticed the Earl of Shaftesbury, Sir Emerson Tennent, Mr. Adams, United States minister; the Duke of Somerset, the Right Hon. Stuart Wortley (Chairman of the Atlantic Company), Mr. Cyrus Field, Mr. C. Buxton, M.P., Mr. Lefroy, M.P., Mr. Crum-Ewing, M.P., Mr. Varley, Mr. Gurney Barclay, Sir Cresswell Cresswell, Dr. Stephenson, M. Gerard Cresswell, Mrs. Cresswell, Chevalier Bonelli, Lord and Lady Robert Churchill, Mr. J. W. Brett, Dr. Wallich, Chevalier and Madame de Bunsen, Mr. Cropsey, Lady Victoria Ashley, Mr. H. Schutze Wilson, Sir Thomas Trowbridge, Professor Wheatstone, Mr. E. Egerton, M.P., Sir C. Bright, Captain C. L. Peel, Mr. George Godwin, Mr. Moran, Hon. E. Ashley, Professor Rogers, Mr. Glass, Mr. Bevan, Mr. and Mrs. Thomson Hankey, the Marquis D'Azeglio (Italian minister), Mr. H. F. Barclay, Lord Alfred Churchill, Mr. Schenley, Mr. and Mrs. Gurney Hoare, Captain Du Cane, Mr. Whitehouse, Mr. Lampson, Countess of Gainsborough and Lady Victoria Noel, General Wylde, Bishop of Ohio, Hon. and Rev. B. Noel and Miss Noel, Colonel Cavan, Mr. T. Brassey, Mr. George Saward, Sir Culling and Miss Eardley, Dr. and Mrs. Lushington, Mr. Banbury Roberts, M.P., Mr. Hubbard, M.P., Sir Fowell Buxton, Monsieur Musurus Bey, the Hon. Gerald Noel, Mr. J. C. Ewart, M.P., Lord and Lady Monteagle, &c.

For the important occasion the London District Telegraph Company, and the Electric and International Telegraph Company, led their wires into Mr. Gurney's house, and during the evening messages were transmitted direct to Falmouth, Edinburgh, Glasgow, and elsewhere in Great Britain, and *viâ* the Hague line, direct communication was obtained so far as Odessa and Constantinople, and during the evening almost every important town in Europe was communicated with. The company assembled had thus the opportunity afforded them of witnessing with their own eyes the actual manipulation of Morse's delicate and beautiful instruments by some of the expertest of operators, and the wonderful results developed by the prompt and ready obedience of the dainty spirit which, at the motion of a finger, as it were, "puts a girdle round the earth in 40 minutes." There was one noteworthy fact, however, educed from the experiments which seemed to escape the attention of all but very few. It was the perfect insulation of the submerged cables, and their comparative exemption from such accidents and adverse influences as those which affect wires conducted overland. For example, the communication from 25, Prince's-gate, through the North Sea and Heligoland to Tonning, was instantaneous; but thence to Copenhagen it was arrested in consequence of the damage done by a recent storm. A railway accident by which several telegraphic posts had been laid low interrupted the communication beyond Turin; whilst east of Odessa the land telegraphic communication had been affected by the hot weather and recurring thunderstorms. Amongst other messages which reached Mr. Gurney's was one from the Earl of Carlisle, at Dublin Castle, bidding success to the Atlantic Company's enterprise, and expressing a hope that Valentia would again form the eastern terminus of the new Anglo-American cable. In addition to Morse's apparatus, with which the correspondence was maintained, Sir C. Bright's and Henley's instruments were also exhibited, and put in action, supplying a fund of amusement to numerous fair amateur operators. Charts, maps, and specimens of telegraphic cables, were likewise displayed for the inspection of the company, and no little interest was created by production of the original reply in telegraphic stenography of President Buchanan to the Queen's message, and which was received at Valentia on the 19th of August, 1858, and the first service message which arrived at Trinity Bay, from Valentia, three days after.

The company having adjourned to the drawing room,

The Right Hon. Stuart Wortley (chairman of the Atlantic Telegraph Company) briefly addressed them, and observed that his hon. friend Mr. Gurney, taking a deep interest in the science of telegraphy generally, and more especially of submarine and ocean telegraphy, and being also a member of the Atlantic Telegraph Company, had invited them there that evening for the purpose of diffusing information upon the subject. There were persons who doubted whether the Atlantic telegraph cable had been anything but a myth, or whether any message had really passed along the line. But the fact was, that not only had messages passed, but during the three or four days that the cable was in operation, messages were transmitted by it of the utmost importance. He did not speak of the complimentary messages that had been interchanged between her Majesty and the President of the United States, though the fact that such friendly communications had passed between the first magistrates of two such great nations was not without its significance and importance. Besides these, practical messages were sent that had had most remarkable results; and amongst them was the communication of the news from China, which was conveyed in a flash of a few minutes from the shores of Europe to Ireland and North America, and was known on the New York Exchange almost as soon as on that of London. There was also the intelligence of the collision on the bank of Newfoundland of the steamers Europa and Arabia. And next, there was the fact that orders having been sent out to Canada to dispatch a regiment to India, and news of the suppression of the Indian mutiny arriving here soon after, a message was forwarded to America by the Atlantic cable countermanding the embarkation of the troops, thus saving a considerable expenditure. Since the failure of the Atlantic cable, great progress had been made in the science of ocean telegraphy. This was apparent in the instruments, which had been so much improved as to enable electricians to test the cable with greater accuracy, to detect faults, and ascertain the speed at which a cable of a given length would work, and the machinery for transmitting and translating messages. The Atlantic cable was supposed to be lying in one place at a depth of 2,500 fathoms, and its length was 1,600 miles. Now the telegraph from Toulon to Algiers, established with the assistance of the French Government, came nearest to that of any that were in working order—it being 600 miles long, and lying at a depth of from 1,600 to 1,800 fathoms; and when that cable was discovered to have a knot in it, it was found possible to take it up, cut off the knot, splice the line and restore it to the water in good working order. It was an erroneous impression, then, to suppose that submarine telegraphy had failed. On the contrary, results proved that the science was gradually and rapidly advancing, and the experience gained enabled practical men to look forward to the employment of cables of such lengths and at such depths as could hardly have been contemplated a few short years ago.

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Mr. Cyrus W. Field said he had received the thanks of friends in America for bringing before the United States Government the necessity of making a communication between Old Point and Washington, by a wire across the Chesapeake, the laying of which was completed directly after the engagement of the *Monitor* with the *Merrimac*, and the first telegram was the one announcing that successful engagement. He quoted an article from the *New York Times* announcing this fact. The excitement in New York was intense. The fact that he had received the warm thanks of friends in America rewarded him for the time he had devoted to the service of telegraphy; and if it had caused satisfaction that such a small obligation should have been rendered, what would be thought hereafter that they had been the means of laying a cable between England and America? He believed the time would come when those in London who had so liberally contributed towards this enterprise would be rewarded. The importance of its completion could not be over-estimated, and it was useless for him to add one word of his about it.

Mr. Cromwell F. Varley was then called upon by the Right Honourable Stuart Wortley, and introduced to the company as the Electrician of the Electric and International Telegraph Company, and of the Atlantic Telegraph Company. He stated that had a little more notice been given him, he might probably have been able to illustrate to them practically some of the great improvements that had been recently introduced in the manufacture of materials, upon which the success of the Atlantic cable chiefly depends. It would be useless for him to say anything about the question of successfully laying the cable across the Atlantic; that had already been once accomplished, and not only been done, but had been repeated across the Mediterranean on three occasions; on two of which, namely, in the cable between France and Algiers, and the cable between Toulon and Corsica, depths had been passed over successfully which were equal to any which would have to be met with from Newfoundland to Valentia. The question then simply resolved itself into two points; the first, the question of insulation, which was the vital one; and the second, the speed of communication that was to be obtained, when the cable was submerged. Neither of these subjects were any longer in doubt. At the time that the Atlantic telegraph was laid telegraphy was in its infancy. But 15 years since, the Electric Telegraph Company commenced its lines, and then people scarcely believed in the possibility of sending a message from London to Birmingham; and had any one ventured to prophecy that this evening, Saint Petersburgh, Austria, Odessa, and other places, would have communicated direct to this house, he would have been set down as little less than a madman. Such were the strides that electric telegraphy had made during the last 15 years. Gutta percha was the substance that had been hitherto successfully used for insulating the conducting wire from the ocean, and it was due to the Gutta Percha Company to say, that since the failure of the Atlantic telegraph they had set to work with perseverance, and had brought all available practical science to bear on the subject, and they brought out results that could scarcely have been expected. If he had had an opportunity of producing a piece of the thin sheet gutta percha as manufactured three years ago, and a piece of what is now made, the one would have had the appearance of white calico, and the other of glass, owing to the present high state of perfection in the manufacture of the material. That which was originally a porous material was now no longer so. With regard to the speed, the experiments that had been recently made with the cable submerged between Malta and Alexandria, set at rest the doubts as to the law on which the speed depended. Professor Thomson explained the theory by mathematical reasoning, and he had the satisfaction of constructing an instrument that confirmed the theory by actual experiment. The subject that had given rise to fear more than any other, had been whether gutta percha was porous or not; would it be penetrated by sea-water when it was placed at such enormous depths of the Atlantic? There was some reason for this fear, for it would be remembered that an experiment was made many years ago to ascertain that water was compressible; and it was tried by compressing water in a ball of gold. When the ball was compressed, the surface of the gold was found covered with dew; the water had passed through the pores of so perfect a material as solid pure gold. When bottles had been sunk to a great depth in the ocean they had invariably come up filled with water. Now had that water passed through the glass or through the cork? To decide that question, and to make the matter more certain, the cork was sealed over, and when the bottle came up the cork was found to be upside down. They had made a still better experiment in the Red Sea and Mediterranean, in the soundings for the purpose of telegraphy. In order to ascertain the temperature at great depths, thermometers had been lowered down to the bottom of the ocean, and although their thin bulbs withstood the pressure, it was thought they might be compressed, and give false results. The first bulb was then encased in another exhausted glass bulb, so that if the outer one were compressed, it should exercise no compression whatever on the inner one. These bulbs were sent down and taken up many times, and in no case had water passed through the glass. Gutta percha is a soft substance, and fears had been entertained that pressure would cause water to penetrate into its supposed pores; but Mr. Fairbairn, who was appointed by Government to examine into this subject, and others, had found that the insulation of gutta percha under a compression equal to many miles of ocean depth, was invariably improved. In one experiment which he (Mr. Varley) had made with india rubber covered wire, in which the layers of india rubber were not properly united, the insulation was found to be almost perfect; but when the pressure was taken off, the coatings were found to have separated. The reason why no fear should exist on the subject of porosity he thought was simple. Everybody knew who had walked through the snow, how snow water penetrated into the leather. Yet it is this same leather that is used to make the joint of the hydraulic ram, and that leather, owing to the water compressing it upon itself, becomes impervious. As to the advantage of an Atlantic communication so much had already been said, that he (Mr. Varley) would only add a very few words. It must be borne in mind that it was to connect the whole telegraphic system of Europe with a continent possessing a network of telegraphs unrivalled anywhere, and a country shortly to be peopled as thickly; and all Europe was as much interested as America in seeing it carried out. The Trent affair had already occasioned on the part of the British Government an expenditure sufficient to lay down many Atlantic cables, and when they took into consideration the injury done to business, and the stagnation of trade during the interval of suspense between peace and war, they would find, at a very moderate calculation, that money enough was lost to have bound England with America more than twenty times over. It is an interesting fact to know that from Valentia to Newfoundland really a very large amount of communication did take place, too insufficient prominence had been given to that fact. The cable worked for a period of about 20 days, and during that interval, 271 messages were sent from Newfoundland to Valentia, consisting of 2,885 words, and 13,968 letters. From Valentia to Newfoundland there had been transmitted 129 messages, consisting of 1,474 words, and 17,253 letters. Some of the messages which had passed through that cable had already been alluded to, and the fact that messages of such importance having passed, showed that if an Atlantic cable should only last twelve months, it would be cheap to the country to lay one annually. Experience, however, had shown that the old gutta percha cable, laid ten years ago, is now better in an electrical sense, than on the day it was laid; and the consequence was that gutta percha might be looked upon at present as imperishable; he knew of no end to it. He added, (at the request of Mr. Wortley,) that with regard to the speed of communication through the contemplated cable, he thought it would be four words per minute; but the improvement of gutta percha would probably enable them to step one wave higher than they had hitherto been able to do, and that wave signified double the speed. It was probable that with improved apparatus they would be able to step one wave higher still, which would give them the speed of four times four, or sixteen words per minute; in a word, it was not too sanguine to anticipate that science would show them how to work at four times the speed obtainable four years ago.

Mr. Adams, minister from the United States, entirely reciprocated the spirit in which Mr. Wortley had spoken. The proposed telegraphic communication was interesting to both England and America; but for many reasons it was obviously proper that Great Britain should take the initiative. All that he was then authorised to say on the part of his Government was that, having the greatest confidence in the judgment and integrity of the British Government, and satisfied that they would not agree to any plan without mature consideration, the United States Government were ready to co-operate with them in any manner they might determine to adopt.

The subjoined message was received at 58, Threadneedle Street, too late for the *conversazione*.

The message occupied one hour in transmission between London and

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Constantinople, and we confidently expect that in a few years such a communication will only occupy a few minutes.

"ALEXANDRIA, March 27, 12.20 A.M.

"The Prince of Wales leaves Cairo, for Alexandria, to-morrow, and leaves for Jaffa and Holy Land on Friday. The Prince has been highly delighted with his visit to Egypt and his Nile trip. He had good sport, and is quite well.

"The Duke and Duchess of Saxe Coburg and suite leave Suez, per Odin, for Massowah, on a shooting excursion.

"The Japanese ambassadors left Alexandria at six a.m., on the 25th, per *Himalaya*, for Marseilles. They intend first visiting France.

"Viceroy ill, at Kafir el Mis.

"No political news here. Weather fine."

THE EARTH, AS PART OF A CIRCUIT.

The poles of a battery, when disconnected, have equal and contrary tensions.

When insulated conductors are placed in contact with them, they themselves become the poles of the battery, the battery having furnished a current sufficient to charge them, but not of sufficient duration to move a galvanometer needle.

If the conductors are lengthened, the time occupied in charging them will increase, until, as they are still further lengthened, a limit will be reached at which the current will last long enough to affect the galvanometer, and when the conductors become infinitely long or infinitely large, the time occupied in charging also becomes infinite; or, in other words, the current will pass precisely as if the poles were connected by a conductor.

Thus, when the extremities of a circuit are connected to the earth their respective tensions are communicated to it. But as the earth is infinitely large, compared with any artificial source of electricity, it can never become *charged* by a battery, however powerful.

Thus the tensions of the earth plates are diffused in all directions without producing any difference in the electrical condition of the earth itself.

This is Gavarret's theory.

The earth acts also as an ordinary conductor, and opposes some resistance to this diffusion; for every conductor, however good, offers some resistance.

When a layer of soil placed in a box is compared with a similar layer, forming part of the earth's surface, it is found that the isolated portion offers the greater resistance. Its resistance follows the same laws as that of any other substance; depending on its dryness, or dampness, its nature, and its length, and section.

If two earth plates be buried in the soil, the resistance of the portion included between them does not vary in the ratio of their distance, as it would if the portion were enclosed in a box.

Matteucci gives the following results, the size of the plates being the same:—

		Resistance.			Resistance.
Plates	1 yard apart on the level plain	68	on a mountain		152
„	5 „ „	97	„	„	—
„	10 „ „	102	„	„	222
„	20 „ „	109	„	„	—
„	50 „ „	123	„	„	531
„	100 „ „	—	„	„	849

The resistance diminishes with the depth to which the plates are buried.

When buried	4	inches the resistance was		91
„ „	10	„	„	83
„ „	40	„	„	74
„ „	80	„	„	70

The size of the plates has the greatest influence on the resistance.

If a plate containing	1	square foot of surface gives a resistance of			174
„ „	4	„ „	will give	„	140
„ „	16	„ „	„	„	81
„ „	25	„ „	„	„	47
„ „	32	„ „	„	„	31

But, after a certain *size*, varying with the conducting power of the soil around the plates, the resistance remains constant. In the sea this limit is very quickly reached. After a certain *distance*, varying with the conducting power of the soil and the size and depths of the plates, a further increase of distance makes no difference in the resistance.

This diffusion, or conduction, does not take place solely in the direct line between the two plates, but extends in curved lines on all sides. It is thus easily seen why the resistance decreases with the depth of the plates—is less on a plain than on a mountain—and is greater when a portion of soil is isolated by being placed in a box, for then the conduction takes place only in the direct line.

On short lines the resistance of the earth to the diffusion of the current is a matter of the greatest importance. If the earth terminals of the several circuits or wires are connected to one and the same earth plate, it becomes a question of comparative resistances, whether a current sent on one wire shall diffuse itself through the earth, or shall divide between the earth and the other wires; for at short distances the earth acts simply as a conductor. The earth plates should in this case be large, and be buried deep in the soil, wet, at all seasons.

It sometimes happens that an "earth cannot be found" in places where there is but a thin layer of soil covering rock, or where the soil is constantly dry. In this case two courses are open:—

1. To increase the resistance of the line by means of fine wire till it becomes greater than that of the soil. This is objectionable, as it increases the length of the circuit.

2. Instead of connecting all the wires to the same earth plate, to use separate plates buried 20 yards or more apart, and separate earth wires. So that the resistance of the soil between the plates is sufficient to prevent the current passing from one earth plate to another.

To test an earth plate, send a current on the longest wire, and place a sensitive galvanometer in the shortest; one fixed on separate poles, if there is more than one line of poles connected with the office. If no current passes through the galvanometer the earth is perfect.

A water or gas pipe is preferable to a plate, because of its larger surface. Care must be taken to connect to the main street gas pipe, not to a branch pipe, as the joints indoors are frequently packed with white lead, which is not a good conductor.

A deep trench filled with coke, in which a copper wire is buried, may sometimes be used, bearing in mind that the object is to expose as large a *surface* as possible.

Plates must never be coiled, but should be buried flat, as they then expose both their surfaces.

R. S. Culley.

March 27th, 1862.

INTENSITY AND TENSION.

BY "AU REVOIR."

An intelligent contributor to one of your late numbers remarked that, "Nothing is more perplexing to the student of electricity than the inappropriateness and inaccuracy of many of the most important terms," and among those he particularized are *tension* and *intensity*. Electricians might well turn their attention to the anomalous positions of those two words just at the present moment, and certainly more in the spirit of the grieving than the laughing philosopher. There can be no doubt the expressions were originally suggested by the universal notions of the *tenseness* of a musical string, and the *intensity* of sound which it occasions, as well as by a variety of other *conditions* in material things and *consequences* of those conditions that have been observed to vary one with the other. But we are getting beyond that simplicity and perspicuity now in electrical matters, for besides the "intensity of the tension," which has been thought by one writer "no superfluity of language," we find on all sides either an indiscriminate use of the terms, or such departures from their original idiomatic meanings, that it ought not to surprise us if we were to find some celebrity insisting upon it that the *tension of the intensity* would not be an extravagant or inappropriate expression. My intention is not to enlarge upon this subject, but merely to reiterate Mr. Preece's call for attention to it by adducing a few evidences readily at hand of the necessity for a better understanding than at present exists. Sir Wm. Snow Harris put a broad distinction between intensity and tension; he not only conforms, as far as possible, to the old popular conceptions connected with the two terms, but he insists, likewise, that the former is of a nature to vary as the squares of the quantities of electricity to which it is due, and that the nature of the latter is such that it varies in the simple ratio of those quantities. Degree of intensity, he says, expresses the amount of electrical force by which the normal condition of matter is being attacked; while tension implies the force of resistance that the matter opposes to the attack. This seems the right view to take, but in the laws assigned by this writer to the two things there seems to be something to object to, for it is difficult to suppose matter succumbs to an attack made upon its normal state in that exact ratio which makes its resistance to electrical change just equal to the square root of the attacking force; surely that must be a

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fable, or where is the acknowledged equality of physical cause and effect—action and reaction?

Those readers of this journal who have followed Mr. Latimer Clark in the expression of his opinions with reference to intensity and tension, will have observed that that gentleman has a decided predelection for the latter word, because he believes the former is being ill-applied, while the latter is used in its legitimate signification, and "has no ambiguity of meaning." Whether it have or not, we may judge by the state of Mr. Clark's own mind concerning it, as evidenced by what he has lately made public. In No. 21 of The Electrician, he writes:—"The attractive force is well known to increase as the square of the quantity of electricity," and "as the square of the tension." And again, "between electrical tension and electrical intensity I know of no difference." Now, if the attractive force vary as the squares, both of the quantities and the tensions, then "the quantity must vary directly as the tension, as he said it did in No. 11 of The Electrician. But if tension and intensity be not different, then quantity, tension, and intensity vary simply with one another. What then is the electrical force which varies as the squares of all three—quantities, tensions, and intensities? Surely this is neither using the term tension without ambiguity, nor showing its proper relation to intensity; nor is there anything in it to reconcile us to the depriving either term of the idiomatic signification that custom has assigned to it.

It appears to me that before we can prudently follow Mr. Clark's example in banishing the word intensity from our electrical vocabulary, and making use of tension in the way he has proposed, we must wait for more light. If by such an analysis of facts as Mr. Webb is undertaking in these pages, we get to know the character of the resistance which matter opposes to electrical action, we may possibly find, as Sir Wm. Snow Harris has suggested, that tension is a proper term to apply to it; but if, further, we could find out the *nature* of the resistance, together with that of the electrical action which has to overcome it, we should do better still, for in that case we might be almost certain of properly applying also the other term—intensity, and that, probably, without supplanting the common idea associated with either of them. The "Steps to Theory" seem to be leading up to that end, and it is to be hoped they will in due time arrive there by shewing how the number and size of cells in battery arrangements are related to quantity in a wire; if we knew *that*, we should probably have no difficulty in finding for the terms now in question their proper places.

RED SEA AND INDIA TELEGRAPH.

The *Mechanics' Magazine* gives the following details respecting the progress of the Telegraph to India Company:—

The expedition of the Telegraph to India Company (says the *Times*) which left this country about two months since for the purpose of repairing such portions of the Red Sea cable as are not too far gone in dilapidation is, it appears from recent advices, progressing very favourably with the work, and it is hoped that before long some of the most important sections will be open to the public. It may be remembered that at the period of the failure of the Red Sea lines some sections were reported to be in comparatively good condition, and it is these portions which Mr. Latimer Clark and his electrical and engineering staff are now endeavouring to restore. This, however, is only one of the objects of the expedition, for so disastrous has been the experience of submarine wires in the Red Sea, that it is the intention of Sir C. T. Bright and Mr. Clark, the engineers of the company, to do away with a large portion of the sea route altogether, by carrying a land line through Upper Egypt and Nubia along the banks of the Nile, and thence crossing an arm of the Desert (about 90 miles broad) which separates the Nile Valley from the shores of the Red Sea. Mr. Latimer Clark's applications to the Pasha of Egypt to give this scheme his countenance and protection have been entirely successful, and as the Pasha himself has a telegraph up the Nile for nearly 700 miles of the proposed route, there seems no doubt but that this most important link in the line to India will soon be completed.

With a view to insure the wires being thoroughly and efficiently protected throughout, Mr. Clark, with Mr. Rolfe and several of the Pasha's officers, has been up the Nile to arrange with the Sheiks of the different tribes through which the line will pass. The conference with the Sheiks was most successful, and they are now all pledged to the protection of the wires. As they have previously been employed by the Viceroy, with great success, in looking after his telegraph, there is no reason to doubt their ability or willingness to do so in the case of the Indian line, especially as they are to be paid for it, and there is no inducement to a Bedouin like a promise of "backsheesh."

In the meantime, other portions of the expedition have been dispatched to examine and report upon that section of the Cossier and Suez line that extends as far as the Island of Shadewan, at the entrance of the Straits of Jubal. This portion, from tests taken by Mr. Laws, was supposed to be, if not absolutely perfect, at least in sufficient good order to be capable of being worked for a considerable time.

To complete the repairs of this section, therefore, Mr. Laws, with Mr. Brunton and Mr. Woods, was sent in the Egyptian steam sloop *Gabari* with a strong working electrical and engineering staff, to carry the line as far as Jubal, and open a temporary station there to intercept and forward messages from the Indian mail steamer. The *Gabari* arrived at the scene of operations on the 14th of February, when a very cursory examination was sufficient to show that the bottom was of the most unfavourable kind for grappling a cable, as coral reefs abound on all sides. But before any operations could be undertaken the rough weather, which seems to wait upon all telegraph operations, set in in earnest, and the *Gabari* was obliged to retire to the doubtful shelter of the coral reefs to wait for an abatement of the gale. Ten days elapsed, however, before the weather moderated. On the morning of the 24th operations were renewed, and, after a few casts of the grapple, the line was hooked, but owing to its having been laid out quite tight it broke in hauling to the surface. A buoy to mark the spot was immediately let go, and soon after the end was brought on board from 57 fathoms water, and the lifeboat was sent to recover as much cable as would be sufficient to land the end on the Island of Jubal, about five miles distant.

The work having to be carried on entirely by manual labour, and without appliances of any kind, was necessarily slow and difficult, and at dusk the vessel had to be anchored and the end buoyed for the night. It had, however, been sufficiently long on board to prove that for all practical working purposes the wire was in good order. So much has been said about the instability of submarine lines laid in comparatively shallow water that the raising of this was looked forward to with considerable interest; yet, when brought to the surface, even after having been subjected to the action of the waves over the coral rocks for three years, it was found to be but slightly altered in outward appearance.

A close examination showed that in some place the wires were corroded slightly, but still the black coating of mud and oxide with which it was covered so closely resembled tar that it seemed at the first glance impossible to believe that the wire had been down more than a few months. The *Gabari* then continued to underrun the line till within a mile and a half of Jubal Island, and the accounts state that it is difficult to imagine anything more beautiful than the mass of zoophites, of every tint and colour, which had cased round the whole cable to the thickness of several inches. These being mostly of a soft tenaceous nature would tend most materially to preserve the outside iron wires from decay. On the 26 the *Gabari* underran the the shore end of the cable to Cossier, in order to remove it and lay it to Jubal Island. Though the portion of this line had only been down some 14 months yet it was found on raising to be completely encased in a protecting sheath of coral and zoophites.

Mr. Clark is now at Aden waiting for the *Sir James Duke* with the cable; and has probably by this time already entered upon the business of repairing the eastern sections of the line between Aden, Kooria Mooria, Muscat, and Kurrachee.

The Student.

DISTRIBUTION OF TENSIONS IN THE BATTERY.

It is time that we should enter into the important question of the distribution of tensions in the voltaic battery, and in so doing we will endeavour to divest the subject, as much as possible, of all technicality. It has been stated that the electricity furnished by the battery is of the same nature as that produced by the electrical machine; the difference being merely in the quantity supplied, and in the degree of tension. With a sufficiently large electrical machine the quantity of electricity produced may be sufficient to be indicated upon the galvanometer when the electricity traverses a circuit of wire. On the other hand, with electricity of high tension from a battery of many alternations, an electrometer, the instrument for indicating the presence of what is termed static or frictional electricity, may be influenced by contact with either of the battery terminals; the positive terminal acting as an excited rod of glass, and the negative terminal as a stick of sealing wax rubbed upon woollen cloth. But we would at the outset impress upon the electrical student, that it is not indispensable for the

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production of a voltaic current that one of the battery terminals should supply positive, and the other negative electricity. It is essential, merely, that between the two there should be a difference of tension; and both terminals *may* be positive or both negative, when tested by the electrometer, providing there be this difference in the *degree* of tension, necessary for the production of the current.

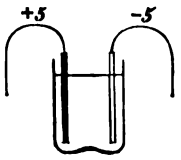
Let us take a vessel of pure water, and a piece of pure zinc. The observation and application of many facts leads us to class the zinc among the bodies we term *electro-positives*, which, in electrolysis, are separated at the negative pole of the battery, and to regard the water, containing the *electro-negative* oxygen, as electro-negative in regard to the metal. We may consider ourselves justified, in considering the chemical affinity of the zinc for oxygen, as a consequence of the opposite electrical nature of these two bodies. But, in regard to their present electrical condition, we cannot be far wrong in assuming that they are both in electrical equilibrium with the earth; although, under ordinary circumstances, this may not be strictly true, as the zinc may be slowly undergoing chemical action by combination with the oxygen of atmospheric moisture. Let us now immerse the metal in the fluid; chemical action will take place, the zinc will assume a negative tension, and the water a positive tension. It would require a very sensitive electrometer indeed to indicate these tensions; but the experiment, which becomes easy with a number of alternations, has repeatedly verified what we now advance.

We already know the utility of sulphuric acid in removing the film of oxide which forms upon the surface of the zinc, and the advantage of amalgamating the metal when the latter is impure. The addition of the acid increases the chemical action, and the quantity of electricity generated, while it causes this action to become continuous. Let us add a few drops of acid to the pure water; little, if any, further chemical action will take place upon the pure zinc. But if we cause a small particle of copper, gold, or platinum to adhere to the surface of the zinc by a blow with a hammer, chemical action proceeds with rapidity when the zinc is re-immersed in the fluid. The zinc will be eaten away around the less positive metal. Our experience teaches us that the positive electricity generated by chemical action upon the zinc is transferred to the fluid, causing a difference of electrical tension in the two bodies. The action of the less positive metal is to collect this electricity from the fluid, and to re-transfer it to the zinc. Chemical action then proceeds rapidly to maintain the difference of tension between the two. If we now place a drop of mercury upon the particle of metal adhering to the zinc, this particle becomes covered with an amalgam of zinc, and can no longer conduct the electricity from the fluid.*

We may now correctly comprehend the function of the negative element, which is simply to conduct electricity from the fluid back to the zinc, when the circuit is completed. The difference of tension between the zinc and the fluid is the measure of the electro-motive force of the couple, commonly termed the tension of the arrangement.

The following diagram may represent a plate of copper, shewn as a single dark line, and a plate of zinc, indicated by the double line, immersed in dilute sulphuric acid.

Fig. 1.



The zinc, if chemically pure or well amalgamated, will not be acted upon to any very appreciable extent while the circuit is incomplete. A slight degree of chemical action will take place upon the copper; and the difference in the tensions of the elements, *i. e.*, the electromotive force of the couple will be less than that of a couple composed of zinc and platinum, or graphite.

We will represent the opposite tensions of the elements as follows:—that of the zinc as−5, that of the copper as+5. The algebraic difference between these two quantities=10.

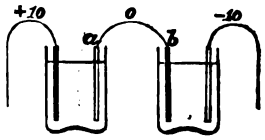
Throughout a series of alternations, the difference between the tensions of these elements in any particular couple will remain constant, *i. e.*, always equal to 10.

The difference in the tensions of the terminals of the battery will be 10, multiplied by the number of alternations.

* We are aware that a different explanation of the mode in which amalgamation protects the zinc element has been given by Professor Grove. The above, however, appears amply sufficient to account for the phenomena.

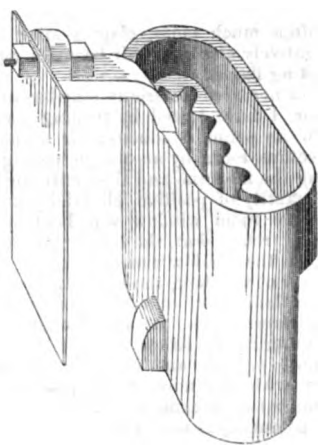
Thus, let us connect together two similar couples for tension.

Fig. 2.



The opposite tensions of *a* and *b* will neutralize each other; the respective tensions falling to 0. The tension of *a* being 0; that of the copper in the same cell will become+10, the difference between these two quantities being equal to 10. The tension of *b* also is 0; that of the zinc element in the same cell will be−10. The difference in the tensions at the terminals of the battery is 20=10×2, the number of alternations.

By again doubling the number of alternations, it is easy to perceive that the tensions at the poles of the battery respectively would become+20 and−20; the difference between these two quantities being 40=10×4 the number of alternations. By drawing the diagram it will be seen that in this case one of the zinc elements will have a tension+10, and one of the copper elements a tension−10; but, although maintained at these tensions, they constitute efficient elements, positive and negative respectively, when connected with the opposite element in the same cell. Thus a zinc element with a tension+10, and a copper element having the tension+20, give precisely the same current, *ceteris paribus*, as a couple with the tensions, zinc−5 and copper+5. In both cases the difference of tensions=10.



THE SINGLE FLUID CAST-IRON BATTERY.

The above wood-cut illustrates the form of Collan's single-fluid battery apopted by Mr. Turton, of Tiverton, near Bath, and referred to in our last number. The vessel, intended to receive the zinc of the preceding couple, is made wholly of cast iron, covered externally with sealing-wax varnish. Internally it is corrugated in order to increase the amount of negative surface. The zinc element is fixed on to the iron arm of the vessel by means of a bolt and nut, and may readily be reversed when the lower half has been partly consumed. The exciting fluid used is one part of concentrated sulphuric acid to 3½ parts of water.

Although this arrangement is somewhat inferior to that of the Maynooth battery both in regard to quantity and tension in the current, its advantages in point of economy and convenience render it generally preferable where very considerable voltaic power is required, as in the exhibition of the electric light and similar phenomena. The contacts being very perfect and secure, a frequent source of difficulty in such experiments is removed, and the battery is readily charged, separated, or emptied.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

J. P. Joule, LL.D., F.R.S., President, in the Chair.

A Paper by Professor W. Thomson, LL.D., F.R.S., Honorary Member, was lately read, entitled "Observations on Atmospheric Electricity."

I find that atmospheric electricity is generally negative within doors, and almost always sensible to my divided ring reflecting electrometer. I use a spirit lamp, on an insulated stand a few feet from walls, floor, or ceiling of my lecture room, and connect it by a fine wire with the insulated half ring of the electrometer. A decided negative effect is generally

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found, which shows a potential to be produced in the conductors connected with the flame, negative relatively to the earth by a difference amounting to several times the difference of potentials (or electromotive force) between two wires of one metal connected with the two plates of a single element of Daniell's. I have tested that the spirit lamp gives no idio-electric effect amounting to so much as the effect of a single cell. The electric effect observed is therefore not due to thermal or chemical action in the flame. It cannot be due to contact electrifications of metallic or other bodies in conductive communication with the walls, floor, or ceiling, because the potentials of such must always fall short of the difference of potentials produced by a single cell. I have taken care to distinguish the observed natural effect from anything that can be produced by electrical operations for lecture or laboratory purposes. Thus I observe generally in the morning before any electrical operations have been performed, and find ordinarily results quite similar to those observed on the Monday mornings when the electrical machine has not been turned since the previous Friday. The effect, when there has been no artificial disturbance, has always been found negative, except two or three times, since the middle of November; but trustworthy observations have not been made on more than a quarter of the number of days.

A few turns of the electrical machine, with a spirit lamp on its prime conductor, or a slightly charged Leyden phial, with its inside coating positive put in connection with an insulated spirit lamp, is enough to reverse the common negative indication. Another very striking way in which this may be done is to put a negatively charged Leyden phial below an insulated flame (a common gas burner, for instance). The flame, becoming positively electrified by induction, keeps throwing off, by the dynamic power of its burning, portions of its own gaseous matter, and does not allow them to be electrically attracted down to the Leyden phial, but forces them to rise. These on cooling become, like common air, excellent non-conductors,* and, mixing with the air of the room, give a preponderance of positive influence to the testing insulated flame (that is to say, render the air potential positive at the place occupied by this flame).

Half an hour, or often much more, elapses after such an operation, before the natural negatively electrified air becomes again paramount to its influence on the testing flame.

That either positive or negative electricity may be carried, even through narrow passages by air, I have tested by turning an electric machine, with a spirit lamp on its prime conductor, for a short time in a room separated from the lecture room by an oblique passage about two yards long, and then stopping the machine and then extinguishing the lamp, so as to send a limited quantity of positive electricity into the air of that room. When the lecture room window was kept open, and the door leading to the adjoining room shut, the testing spirit lamp showed the natural negative. When the window was closed, and a small chink (an inch or less wide) opened of the door, the indication quickly became positive. If the door was then shut, and the window again opened, the natural effect was slowly recovered. A current of air, to feed the lecture room fire, was found entering by either door or window when the other was shut. This alternate positive and negative electric ventilation may be repeated many times without renewing the positive electricity of the adjoining room by turning the machine afresh.

The out of doors air potential, as tested by a portable electrometer in an open place, or even by a water dropping nozzle outside, two or three feet from the walls of the lecture room, was generally on these occasions positive, and the earth's surface itself, therefore, of course, negative;—the common fair weather condition, which I am forced to conclude is due to a paramount influence of positive electricity in higher regions of the air, notwithstanding the negative electricity of the air in the lower stratum near the earth's surface.

On the two or three occasions when the in-door atmospheric electricity was found positive, and, therefore, the surface of the floor, walls, and ceiling negative, the potential outside was certainly positive, and the earth's surface out of doors negative, as usual in fair weather.

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.

Fine	...	...	...	2s. to 2s. 3d. per lb.

India Rubber.

Fine Para	...	...	...	1s. 11d. to 2s. per lb.
Negro	...	...	...	1s. 0d. to 1s. 1d. "
Java	...	...	...	1s. 4d. to 1s. 5d. "

April 3, 1862. Wm. Kirkmann.

* I find that steam from a kettle boiling briskly on a common fire is an excellent insulator. I allow it to blow for a quarter of an hour or more against an insulated electrified conductor, without discovering that it has any effect on the retention of the charge. The electricity of the steam itself, in such circumstances, as is to be expected from Faraday's investigation, is not considerable. Common air loses nearly all its resisting power at some temperature between that of boiling water and red hot iron, and continuously (not, as I believe is generally supposed to be the case, by disruption) as glass does, at some temperature below the boiling point, with so great ease as to discharge any common insulated conductor almost completely in a few seconds.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32 xd	———
20	Do. B 7 per cent. till 1862 .	all	18 to 20 xd	———
20	Do. C. " "	all	9 to 11 xd	———
Stock	Electric Telegraph . .	100	98 to 101	———
5	London District Telegraph .	4¼	3⅞ to 3½ dis.	———
10	Mediterranean Extension Tel.	all	4 to 5	———
20	Red Sea and India Telegraph	all	18¾ to 19¼	———
1	Submarine Telegraph, scrip.	all	3/8 to ⅝	———
1	Do. registered . . .	all	3/8 to ⅝	———
10	Do. " . . .	all	4 to 6	———
2	Telegraph to India . .	1	par. ¼ pm.	———
5	United Kingdom Telegraph .	2¾	1¼ to 0½ dis.	———

Telegraphic News.

TELEGRAPHIC COMMUNICATION WITH IRELAND.

The Electric and International Telegraph Company's new submarine cable, for connecting England with Ireland was successfully laid last Friday, between the coasts of Pembroke and Wexford, in perfect working order.

The cable, manufactured by Glass, Elliot, and Co., is 63 miles in length, contains four conducting wires, insulated with gutta percha and other materials, on the latest improved methods, and is protected by twelve heavy iron strands, the total weight being about 6½ tons per mile.

The novelty introduced in the manufacture has been the coating of the entire cable with a composition (Bright and Clark's patent), for the purpose of protecting the iron from corrosion and decay. It will be remembered that the Isle of Man cable, laid in 1859, was covered with bitumen (or mineral pitch), laid on with yarn in a hot state. An improvement has been adopted in the application of the material to the Wexford cable, by passing it over a wheel with paddles at the side, the lower part of the wheel running in the hot mixture, so that the cable is completely coated with the compound, while there is no danger of any heating of the core when the machine stops, as is the case when the cable is passed directly through a hot substance. The yarns are then laid over the plastic compound while still in a warm state by the same machine and at the same time. The whole is then passed through grooved rollers, adapted to the outer configuration of the cable (allowing for the thickness of coating required), so that it is compressed into a solid mass, filling up all interstices and inequalities in the outside of the cable, and making the exterior coating smooth and regular throughout its length. The rollers are provided with adjustable springs, by which any required degree of pressure may be obtained.

The bitumen is mixed with hydraulic mortar, and the same current is applied to the outside of the compound. The yarn is also prepared with the mixture before being laid in the outer coating, which it prevents from coming off during the laying of the cable, acting like a bandage over it.

The adoption of this principle is likely to have a most important influence on the further progress of submarine telegraphy, as tending to ensure the durability of cables for an indefinite period, and to render investments of capital in such undertakings of permanent value. The Electric Telegraph Company purpose using the same composition in the cable about to be laid between England and Holland.

Mr. Canning, of the firm of Glass, Elliot, and Co., ably superintended the paying out of the Irish cable, from the steamer *Berwick*.

PARLIAMENTARY.

The following discussion took place in the House of Commons on the 31st ult., with respect to insulating materials for telegraphic cables:—

Lord Fermoy hoped that as gutta percha had failed as an insulating medium the Government would guard against its use by the new company.

The Chancellor of the Exchequer said the Goverment were determined not to interfere with such a question, but to leave the company free to choose between gutta percha and india rubber or any other article.

Sir J. D. Hay said that the preparation of gutta percha had been as yet very unsuccessful, and that the only perfect insulation was that procured by india rubber. As Her Majesty's Government had appointed a commission to consider the subject he trusted that the Government would not deem the matter unworthy of their attention.

The Chancellor of the Exchequer had only meant that it was not the business of the Government to fish up the cable from the Red Sea.

Mr. Coningham had understood the right hon. gentleman to say that it was inexpedient for the Government to charge itself with the decision of the relative merits of gutta percha and india rubber.

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THE POWERS OF TELEGRAPH COMPANIES.

Viscount Enfield inquired of the Chairman of Ways and Means if his attention had been called to the extraordinary powers which have been sought, and have been sanctioned by Private Bill Committees to electric telegraph companies and others, to lay down telegraphs, and erect posts and wires along roads, streets, and footpaths, in various parts of the country; and whether he would call the attention of the house to the case on the introduction of the United Kingdom Electric Telegraph Company Bill into that House, should such a Bill pass the other House of Parliament? The noble lord said that, in his opinion, a Bill proposing to invest a private company with such extraordinary powers should be introduced only as a public measure, inasmuch as it would give power to tear up alike public high roads and private ways.

Mr. Massey said the Bill was at present in the Upper House, and until he saw it he could give no opinion upon its provisions. In 1846 considerable powers had been conferred upon private companies, which were, in his opinion, far too extensive to be dealt with in a private Bill. He concurred with his noble friend that a power to interfere with highways would be more properly the subject of a public measure. However, they would have ample opportunity to consider the provisions of the measure when it came before the House.

Recent Patents.

2234. M. Henry, *Fleet-street, London*, "*Signalling on railways by means of electricity.*" A Communication. Dated 6th September, 1861.

The object of this invention is to signal on railways, by means of electricity, with a view to the prevention of accidents; and the nature or principle of the invention consists in arranging and combining apparatus for that purpose, in which a conducting wire is used, to bring together or effect a meeting between the currents of the positive poles of two batteries (one of which the patentee herein calls the "local" battery, and the other the "travelling" battery), the respective negative poles of which batteries communicate with earth, by which means an alarum furnished with electrical detent, and situated in the circuit of the negative pole of the travelling battery, is caused to remain silent; but the apparatus is so arranged that the action of the local battery may be instantaneously interrupted, when required; and the aforesaid conducting wire, which had hitherto opposed the current from the local battery to that from the travelling battery, becomes a conductor to earth from the positive pole of the travelling battery, and the circuit being closed, the alarum included therein is caused to sound, and this alarm being placed on a locomotive or other convenient part of a train, will, consequently, call the engine driver's attention in case of danger.

2298. T. Morris, R. Weare, *and* E. H. C. Monckton, *Trafalgar-square, London*, "*Batteries for obtaining electric currents, and the products therefrom.*" Dated 14th September, 1861.

This invention consists of an arrangement of battery cells, by which the plates or cells are not immersed, as is ordinarily the case, in a trough, and whereby the intensity of electricity is obtained more readily, and the electric current is less likely to escape. And also in the mode of producing the chemicals or excitants for the batteries; and also of an improved mode of making the cells and the divisions thereof; and of a general arrangement of earth or mineral batteries, and the useful results obtained therefrom. The patentees make these cells of two or more divisions, one of which is raised in order to act as a reservoir for the others. The tops of the cells are closed to prevent the contents from being spilled. They insert a tube or tubes therein to admit the solution to pass in. They employ wood as a porous diaphragm, and make it more porous, and free it from resinous substances by means of caustic potash or soda. They also employ bark in the construction of the porous cells, such as stringy bark or birch bark. They construct their earth or mineral batteries by digging a suitable reservoir or reservoirs, and lining the same with glazed brick or tile, or other suitable non-conducting material, into which they introduce various minerals and chemicals, which act upon one another, and, while producing an elastic action, form chemicals which are applicable to the formation of other batteries, and are also useful for other purposes, as for forms and moulds, so as to render the battery inexpensive, and even productive. Other reservoirs may, however, be used. In reference to the mineral battery, the present arrangements are as follow, for example:—The patentees take an oxide or ore of copper, and mix with it chloride of sodium, and fill one reservoir having carbon electrodes in one cell, and in the other cell, which is divided by a porous diaphragm, they put dilute sulphuric acid, and another carbon electrode or two platinum electrodes, or other materials not acted on by the solution. The result is the formation of sulphate of soda and chloride of copper, both saleable articles, and with the additional advantage that, if the ingredients are rightly proportioned, the double decomposition prevents any unpleasant effluvium from the escape of gas or vapour. In a similar manner other ores, minerals, and chemicals may be employed to produce an electric current and similar products.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

THEORY A GUIDE TO PRACTICE.

To the Editor of The Electrician.

Sir,—"Au Revoir," in his letter to you in The Electrician, of March 21st, says of your "Steps to Theory," they "aspire to convey intelligible views of electricity and its forces;" but, perhaps, your readers in general will not understand that as implying they are of a decidedly practical character, I have followed them from the beginning, because they neither leave facts unexplained, nor advance themselves in any direction without bringing forward facts in their support; a theory of that kind is sure to improve practice when it is understood, and how much it would be difficult to foretell, it is scarcely possible to read yours with common attention without understanding it, and gaining from it, what I for one have never been able to gain before—an insight into the nature of electricity and its mode of action that satisfies my reason.

I offer these remarks, because I believe it would be detrimental to electricity if your "Steps" were to be confounded with theories (so called) which are either speculative generalities without reference to the only test of truth-quantity, *i. e.*, numbers and measures, or narratives of isolated facts with imaginary additions emanated from no system that can hold itself together.

Philo.

PRACTICE AND THEORY.

To the Editor of The Electrician.

Sir,—"Inspector" will doubtless be able to answer for himself. I know what his object was in withholding part of the information he possessed. He wished to afford a theorem for solution, and thus to create an interest in your pages among his fellow officers. He has succeeded.

Most of those employed in telegraphy are simply *practical* men who "do not see the use of theory." Our object should be to entice them to study by shewing them it *is* of use, and this can only be done by giving cases in which theory can be simply and clearly applied.

"A Superintendent" has done this in his solution of "Inspector's" theorem, and many of your readers are a great deal wiser, and very much more tolerant of theory than they were before "Inspector" wrote.

March 27th, 1862. An Old Hand.

P.S.—It strikes me "Momus" and "P. Q.," who I suppose are interested in decrying each other's wares, would do all the better if they brought forward practical examples instead of arguing the question theoretically. Then we should be interested too; now I don't fancy we are, though we may be amused.

FAULTS.

To the Editor of The Electrician.

Sir,—The Electrician did not reach me until Thursday morning, consequently, too late to reply on the above subject.

"A Superintendent" (see p. 239), had solved the problem: I purposely kept back part of the information.

"The Post."—Had a voltaic couple been formed it would have made itself visible on the needle in shape of a permanent current.

"Au Revoir" evidently prefers theory to practice, hence he finds fault with my latter word; I think both necessary, and hold that sound theory is the result of experiment, and experiment is practice.

A German and an Englishman were desired to explain the structure of an elephant (so says the anecdote); the former closeted, and amid the fumes of his tobacco, reasoned the matter; the Englishman journeyed to Africa and saw the animal, and, returning, described it as it was, the German as it should be.

I do not feel justified in taking up more of the space kindly alloted for the discussion of this subject, in answering, by paragraph, "Au Revoir's" letter. My meaning was plain. "A Superintendent" understood and concurred.

Inspector.

RAILWAY SIGNALLING INSTRUMENTS.

To the Editor of The Electrician.

Sir,—I will now endeavour to fulfil the promise in my letter to you on the 1st of March; and if you think the instruments I am about to describe are not suitable for tunnel purposes, I trust you will point out their faults and disadvantages, but first let me say a word or two why I object to the common electric instrument and alarum.

Firstly. The needle; you read the signals either from the top or the bottom part; if one to the right of the top part means "yes," and one to the left means "no," it is evident that one to the right of the bottom means "no," and one to the left means "yes." Now, this is quite sufficient to confuse signalmen, who cannot be expected to be so very proficient at working the instrument; of course, this never confuses a telegraphist, for if it did he would soon be detected making errors, and he would be removed or dismissed; but with a signalman at a tunnel-end it is quite different, for he may go on making mistakes until he is found out by causing a *pitch in*, or something more serious.

Secondly. The bell or alarum can give no intelligible information, only

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one monotonous sound, and perhaps when it is most relied upon it has run down, and the signalman finds his companion at the other end in a rage at the inattention.

During the last three months I have visited a great many tunnels on various railways, and at every tunnel I have found dissimilar signals used. The following, I think, is about the most dangerous one I have met with:—The instrument is a double needle; one for the "up," and one for the "down line." When a train has entered the tunnel on the down line, say, the signalman works the down-line needle right and left, until the man at the other end "blocks needle" to the left. When the train has passed out of the tunnel, and the "line clear," the needle is released, and no acknowledgment whatever is given; as soon as the needle resumes its vertical position the succeeding train, if waiting, is allowed to proceed, and the needle is worked as before, and *vice versâ*, for the up line. Were the wire to be broken by an accident, or accidentally, when a train was in the tunnel the instrument would show "line clear," and the succeeding train allowed to proceed—perhaps to destruction. Blocking the needle is a very good plan when properly carried out, but there is certainly little safety in the above plan. Perhaps you will say there should be an acknowledgment given after releasing the needle, and so there should, and at some of the tunnels the instructions are to that effect, but in consequence of there being no proper supervision over the signalmen, they have gradually neglected the acknowledgment until the have entirely disregarded it.

I also wish to protest against the voluminous instructions issued to some of the tunnels, which would occupy two pages of the Electrician, and are almost incomprehensible. I think if Mr. Newman had given a description of the "train signal system" adopted by the London and North Western Railway Company, it would have been interesting to your readers.

The instrument I wish to point out for tunnel purposes, on a straight line of rails, is "Tyer's patent," which requires but one line wire, and is an instrument with two indices or hands, one for the "up," and one for the "down line," and one bell; the hands or needles, whichever you like to call them, have but two movements, from "line clear" to "line blocked," and from "line blocked" to "line clear." The respective indices are under the command of the signalman at the opposite end. The bell is sufficiently loud to be heard at a considerable distance, but it is not a common alarum. For instance, the signalman at A can strike the bell at B as often as he likes. He gives two beats for a "goods," and three for a "passenger train in tunnel;" the B answers by causing the hand of the "up line" to show at both A and B "line blocked," and as soon as the train arrives at B the signalman there causes the hand to move to "line clear," and so on for the down line.

I know of two of the above instruments that have been in use for the last four or five years, and have never been once out of order, but they are only used about five or six times a day.

The above instrument would not answer very well where there is a station or sidings at the end of the tunnel; but the next one I wish to call your attention to I think will. That is, two of Bright's Patent Bells, rung with the direct current and not with the relay, which is rather a delicate instrument; but the bell itself is a strong, robust, lusty fellow, and by ringing the change the alphabet can be sent, or any other code of signals, which at once acts the part of an alarum, and gives the information by sound instead of by sight. It is scarcely possible to mistake the sound, but the flickering of a needle before the eye is at the best of times indistinct.

Bright's Bell Instrument is in extensive use by one telegraph company, but I am not aware of it being used anywhere for tunnel purposes.

I am afraid I have trespassed too much upon your space, and in conclusion beg to inform you that I am not personally interested in the success of the above instruments, but simply wish to draw attention to a subject which I deem to be of paramount importance.—I am, sir, your humble servant,

Inquisitive.

ELECTRICAL ATTRACTION.

To the Editor of The Electrician.

Sir,—I am glad Mr. Latimer Clark is at length enabled to say "the attractive force is well known to increase as the square of the quantity of electricity," and that he confirms his conviction of the law being one of *force*, and not merely one of phenomena, or facts, by an example; he now writes "if *two* particles of electricity, each exerting an attraction of *two* pounds, pull with a united force of four pounds, just in the same manner do *three* particles, exerting an attraction of *three* pounds, pull with an united force of nine pounds; and, similarly, do *ten* particles, each pulling with a force of *ten* pounds, exert a united attraction of a hundred pounds." Here we have a distinct recognition that it is nothing but the electricity that "pulls," and that each of its particles pulls with a force varying as the number that happen to be pulling together. Possibly Mr. Clark thought I needed that example, to make me comprehend a truth which *it was my object to impress upon him*, but let that pass; I am too well satisfied in having so distinguished a proselyte to the doctrine to care about telling him how long I have been preaching it. Here I could let the matter drop, were it not that either he or I must accept the imputation of having fallen into an error, which, even in courtesy, I cannot put my shoulder under, believing the burden to be his. Mr. Clark is only a recent convert to the new law of electrical force; it is not long since he addressed a letter to the Electrician, from which I have before quoted, and must do so again:—"I do not believe that the *attractive force* varies as the square of the quantity. I believe it to vary simply as the quantity." "If we put one measure of electricity it exerts a certain attraction; if we add another measure the attraction is increased four times. Two parts of this force are due to the increase of tension, which is *doubled*, and two to the increased quantity, which is also *doubled*." It is evident, then, that at this epoch, Mr. Clark was of opinion that the forces of electricity increased by *addition* of the sums of its quantities to the sums of the tensions, and that the tensions and the quantities were always in simple proportion to one another, so that the quantities being as the series 1, 2, 3, and 4, the tensions must also be as 1, 2, 3, and 4. Now one added to one makes two; two added to two make four; but three added to three make six, and not nine; and four added to four make eight, and not sixteen. I am compelled, therefore, to repeat what I said before,—Mr. Clark, thinking at that time he had discovered a way to make into a law of phenomena or facts, what was being insisted upon as a law of force, was betrayed by the second term of his addition giving the same result as would be obtained from it by multiplication; and fell into the arithmetical fallacy of substituting multiplication for addition in the cases of all other terms. He does not seem yet to be conscious of his error, but this explanation of it may perhaps turn his thoughts into the proper direction.

March 29th, 1862. Au Revoir.

THE ATLANTIC TELEGRAPH.

To the Editor of The Electrician.

Sir,—I apprehend you will be doing a great and important public duty at the present moment, when public attention is called to the consideration of again attempting the laying of another cable to the American shores, and it is highly desirable that some assistance should be afforded by our Government, but great caution is necessary, because if public money is to be spent, the ministers are alone responsible for any waste of the nation's capital in any enterprise that may be put forward, that will serve the purpose of assisting the private advantages of the few, and never accomplish the great object in view.

We have lately heard a great talk of contractors wishing to stake a large sum on the success of the undertaking, nothing appears more easy than this, as for instance, the contractors could easily ensure a profit of say fifty thousand pounds, and it would well answer their purpose to stake a very large sum on the scheme, by investing in the shares of the Company the large sum of twenty-five thousand pounds, which if lost would reduce the profits of the undertaking to twenty-five thousand pounds, which would be a very nice sum to make, and the contractors might be heard, and with a great amount of truth, exclaim, how sorry they were that the second attempt to lay the Atlantic telegraph cable had failed, and they had only made twenty-five instead of fifty thousand pounds.

So that to avoid disappointments and understandings, and last and not least the sacrifice of capital, I say call up all the recent inventions recorded in the late Government Report, and many others too numerous to mention, which together would form a very important exhibition, and would lead to the formation of a scientific committee, entirely disconnected with any existing interest, or either with the Atlantic Telegraph Company or the Gutta Percha Company, or even with the firm of Messrs. Glass, Elliot, and Company.

As in a matter were the public are concerned, and also in a matter that has been once tried, and has signally failed, every inventor is justified in calling out loudly that he insists to be fairly dealt with, and if his invention is really useless let him be publicly satisfied that such is the case, or if his invention possesses merits worthy of every consideration, why should justice be withheld from him.

I doubt not that the firm of Glass, Elliot, and Company have done their best in the manufacture of submarine cables, but if great improvents have been made why should they not be adopted, and now is the time.

It is highly amusing to read the accounts that appear weekly, giving an account of the particular gutta percha cables at present in working order; but in contrast it would be quite as interesting if the same writers would inform us of the great majority out of order, and destined never to be used again.

In conclusion, sir, the only wish that can be entertained by every right-minded man, is that every thing possible will be done to ensure the second attempt certain of success.—I am, sir, yours obediently,

Citizen.

ATLANTIC TELEGRAPH.

To the Editor of The Electrician.

Sir,—The public attention has been more or less directed to the form of a submarine telegraph cable, fully described in your journal of the 28th instant, which the projectors represent as being suitable for establishing telegraphic communication between Ireland and Newfoundland. The projectors state, moreover, that they will, to a considerable extent, guarantee its working efficiency between those places. The electrical conductor of this cable is to contain 510 pounds of copper wire, 550 pounds of gutta percha, and 13 strands of iron wire coated with gutta percha, and costing the enormous sum of not less than £1,000,000.

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It appears, from the description just referred to, that the external covering for this cable is to be of stranded iron wire (similar to the old Atlantic). We may here ask, what would be the result if any one or more of these wires were broken by elongation in the paying out or otherwise? It might possibly cause a puncture in the core, thereby rendering the cable useless?

Let telegraphic engineers pause before they adopt such a cable. Why not use longitudinal steel wires, in combination with hemp, saturated with best Stockholm tar, as described in some of the specimens of cables experimented upon by the Government Committee; whereby the whole of the strain is completely taken off the core during its exit from the vessels? It would be well for the Government engineers to adopt a cable of this form prior to their advising a guarantee to any company which may have a desire to *monopolize* the manufacture and working of submarine telegraphy.

Has there not been already some 12,000 miles of gutta percha cables laid, out of which some 3,000 or 4,000 are in *imperfect* working order? How is it, may I ask, that with all these *failures*, that our telegraphic engineers are so wedded to a gum of such an inferior description? whilst caoutchouc is superior in possessing much higher insulating properties, and is far more durable in and out of water.

I also refer to the remarks of Mr. Saward, the Secretary of the Company, the failures of which have proved so disastrous to the shareholders, at the same time realized large profits no doubt to a few *millionaires* who may possibly be intimately connected, not only with the manufacturer of that cable, but with the greater portion of submarine telegraph companies which now exist. This is the great secret that our Government must inquire into, and not be led astray by any of the grand *bubbles* of the day.

Mr. Saward, says in his letter that "I have also seen a statement from Professor Wheatstone that a cable has been submitted to him costing much less than the preceding, and would work across the Atlantic at the rate of sixteen words per minute."

I believe a cable can be constructed for half the cost of the preceding one, and by far superior in every respect to the one proposed by Messrs. Glass, Elliot, and Co., the Atlantic, and Gutta Percha Company. Let us hope that the time is not far distant, when all recent improvements in the construction of submarine cables will be brought into existence, thereby giving great facilities for direct communication to all parts of the world at a cheap rate, a boon not to be obtained by the present mode of construction.

Doubtless, there will be many choice specimens in the ensuing International Exhibition from which selection might be made.

As a national benefit to all classes, the field should be thrown open for public competition, before any guarantee is given to any particular company, however influential its members.

Recent reforms in most cases have set aside "men for measures," and put the "right man in the right place."

When the three absorbing companies next meet again in the banqueting halls of the west, in order literally to get at the pockets of the nation through its aristocratic stomach for aid in the cause of ocean telegraphy, then let the nation through its executive be on its guard, nor suffer the intoxicating effects of a jollification, however refined, honoured by the celestial approbation of the upper ten thousand, to deaden its perceptive faculties to the importance of the question at issue, and to the fact that interested motives are not unfrequently at the bottom of many fine and agreeable things; in short, let the public beware!—Yours obediently,

March 31st, 1862. A Tax-payer.

ON SUBMARINE CABLES.

To the Editor of The Electrician.

Sir,—I am gratified to hear from "P. Q." again, with whom I am undesirous of being on any other than the best of terms; and, however we may differ in opinion on important points, I trust we shall agree to do so in the best possible spirit. I give him credit for perfect sincerity in his perference of gutta percha as an insulator; and I claim the same for myself in supporting an opposite opinion; this being accorded, I hope each one will bear the tables turned upon him occasionally without querulousness, or the loss of his accustomed equanimity.

It is certainly a paradox, and a strange one too, that "P. Q." should discard india rubber for precisely the same reason that I discard gutta percha; but it is a still stranger paradox that he should esteem the Government Report so excellent an authority on such a matter, and yet utterly repudiate the results of the labours of the committee, whose patient investigations constitute that report.

And I must say, that that appears to me a queer sort of way of being "more logical," which necessitates us to mistrust the evidence of our own senses in order to square one's preconceived notions with theories which are at best but the results of incomplete and doubtful experiments.

I know not who, or what my shadowy opponent may be, but I can inform your readers that I alas, am no "learned doctor," neither of physic, philosophy, nor flummery; if I were, I should doubtless make my way rapidly by proving (after the fashion of the times), sane people mad, healthy constitutions incurably diseased, and the general mystification of the whole created universe; and should most assuredly fall foul of my own identity; I sincerely trust that "P. Q.," for the sake of his worldly prosperity, belongs to the fortunate class of "learned doctors."

But let us proceed to the examination of these extraordinary phenomena—of that which is not, and yet is; and of that which is, and yet is not. If I were to place before any person a block of common sandstone and a block of marble, that person would at once inform me that the former was porous, the latter not so; but if on the contrary he should say, "I will tell you which is the more porous of the two after I have experimented upon them," I should certainly conclude either that his sense of vision was defective, or that his optics were useless to him, if he could not trust them to decide upon so simple a matter. It was to the same test that I wished to bring the fact of the porosity of gutta percha, and the compact non-porosity of caoutchouc. I said in a former letter, and I now re-assert it, that gutta percha *is a porous substance observable to the unassisted eye*, and that *india rubber is not so*. Can "P. Q.," or any of the eminent authorities he cites prove to the contrary, if they can I will henceforth wear green spectacles. This is an extremely simple matter for your readers to decide upon, if it is not mystified by the diatribes of "learned doctors." Well then, the inference is but natural and logical, that if a porous material be placed in water it should absorb the element in which it is placed; and however eminent the authorities adduced to prove the contrary, I am presumptuously disinclined to accept their unqualified testimony. And so "P. Q." will excuse me if I fail to see that he has been "more logical" in supporting "his views;" or that he has assigned a "better reason" "for the porosity of india rubber" than I have done for gutta percha; if he really has, why then we can very well dispense with one of our five senses, hitherto considered a most important one.

Of the five authorities quoted by your correspondent in support of his first assertion, not one of them but betrays more or less of dubiety in his evidence upon the matter:—one "*does not believe*," a second found "no variation in permeability after long immersion" (a tacit admission of its permeability); a third, "*I believe* gutta percha to be one of the most impermeable substances that has been used for insulation *at present*" (cause why? it was the only substance that had been used, comparatively speaking at that time: at all events it was the only substance which from its long use, any definite conclusion could be arrived at from positive data); a fourth "found it did not imbibe water" (and yet admits immediately after that he "found it apparently to penetrate," &c.); a fifth "*considered*" (only "*considered*,") "gutta percha impermeable." And yet all these gentlemen, with one exception probably, are more or less interested in the continued use of the commodity whose praises, a strict regard to facts, compels them to speak of so hesitatingly. Need I say more.

And yet if one must necessarily set aside the evidence of one's senses, and have recourse to the results of experiment in order to establish the truth of a proposition, I may point to the great amount of inductive discharge of gutta percha covered wires as compared with wires insulated with india rubber, so much so that a coating of the latter is fully equal to a coating of gutta percha of double the thickness. If this is not a conclusive proof of the porosity of the one and the comparative non-porosity of the other, I should be glad to be informed what is. If gutta had to be applied to the wire in spiral layers of thin tapes, it might be urged with an appearance of truth that the loss by induction was caused by interstices where the tapes overlap each other; but it has the advantage of rubber in this respect being applied to the wire in the mass.

Your correspondent has completely failed to prove his first proposition; the authorities he quotes say nothing on the matter; they simply speak dubiously as to its non-absorbing qualities: while on the other hand, authorities equally trustworthy are unmistakable in their testimony of an opposite description; as for instance the Messrs. Siemens, Mr. Macintosh, and others. And then note the result of Mr. Fairbairn's experiments: "The absorption with a pressure of 20,000 lbs. per square inch was for gutta percha *six times* as much at a temperature of 75° as at 45°; and "for *india rubber two and a half times as much*" (Government Report, page xx., or Appendix No. 5).

That the superincumbent mass of water may, by its immense weight, improve the insulation of submarine cables in deep seas, and so help to close the pores of even a gutta percha core, is not improbable; but it is at best but a hazardous experiment to submit a porous material to so problematical a circumstance in order to its improvement.

"Pressure improves the insulation while it is being applied, its effect being more obvious as the material is a *worse insulator;* and there appears to be less difference in india rubber when *subjected* and *not subjected* to pressure than in any other of the materials experimented on" (ibid., page xxi), and therefore, as a matter of course, better fitted for the core of submarine cables than any of the others.

I need not dwell on "P. Q.'s" "secondly," which is simply an absurdity in the way he intends for it to be understood; the foregoing is a quite sufficient refutation of it. I may just say that pores are not to be detected in a block of pure rubber; its absorption of water in the cases referred to in the Government Report, are doubtless to be attributed to defective application of the rubber to the wire, but principally to the inferior quality of the material used. To quote Mr. Latimer Clark in support of this extraordinary proposition will certainly not "help a lame dog over the stile." And Professor Miller's tables are scarcely reliable, since they are overturned by facts simple as they are notorious; had they been otherwise

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indeed, the "Joint Committee" deserved cashiering, for preferring india rubber to gutta percha as an insulator for submarine cables.

The testimony of an eminent and reliable authority on this subject is important, and the gentleman I am about to make reference to I deem of more weight than the whole mass of evidence, *pro* and *con*, given before the Government Committee, with all their elaborate tables to boot. Mr. Thomas Hancock (of the eminent firm of Charles Macintosh & Co.), in his celebrated work on india rubber, relates, that being desirous of ascertaining if caoutchouc were really impervious to water, filled a bag made of fustian, and lined with a thin sheet of india rubber, which he sealed up hermetically; the bag contained 12 ounces of water. During the first year it lost 2 drachms in weight, in the 8 or 9 years following it lost about 13 more, and so on, over a period of 25 years, at the end of which time he cut open his bag and found it quite dry.* Now if a bag lined with a thin sheet of gutta percha will show the same result, I will at once accept "P. Q.'s" proposition without reservation; but no, I will venture to say the bag would be empty in less than a twelvemonth.

But "P. Q." has been fighting with a phantom all the time; I never at any time said that caoutchouc was totally impermeable to water; I never made any allusion to it; I simply argued from the fact of the unmistakeable porosity of gutta percha that it was unfit for the core of submarine cables, and that caoutchouc, from its opposite quality, was the material most eminently adapted for the purpose, and to this opinion I adhere, confident in the incontrovertible facts by which it is supported.

I think your readers "will be inclined to believe" in the sincerity and justice of the conclusions arrived at by the committee appointed by the Lords Committee of the Privy Council, &c., rather than the isolated portions of gentlemen who could scarcely be expected to be altogether impartial in their evidence; or of "an anonymous correspondent" so extremely reluctant to admit that the most meritorious of materials for a special purpose has any merit at all.

And I would respectfully ask in conclusion, can a material be justly said to have rendered "good service" when the sum-total of its failures cause its rather doubtful successes to kick the beam. Properly read, the "historic page" shows that submarine telegraphy has been retarded rather than advanced by gutta percha insulation; it is partly, if not wholly, responsible for 12,000 miles of cable which *should be* in existence, and is not. Momus.

March 25th, 1862.

[Our correspondent is in error in supposing that high inductive capacity is "conclusive proof" of the porosity of a dielectric.—Ed. E.]

THE INDUCTION COIL.

To the Editor of The Electrician.

Sir,—One of your correspondents, after giving a list of his *unsuccessful* attempts, and occupying your valuable space with what might be contained in a nutshell, goes on to give a description of what *he thinks* an original idea in the use of cast-iron for the negative, when it was plainly alluded to in your article on the metal iron, and likewise gives *his* idea of a resistance meter which is exactly similar to the one you lately proposed.

After trying the effect of a *stove-pipe* he complains *again* that he cannot succeed, and that the metal becomes coated with he *knows not what*, and the electricity becomes *nil*, and no doubt throws it away, and has recourse to his *own original* cast-iron negative battery. He complains that Rhumkorf coils are expensive, if he has *perseverance and patience* enough to construct one with copper wire by the method I suggested in one of my letters to you, he will find that a very powerful one may be constructed at a very small expense in comparison with those made on the usual principle. I am now constructing one which will contain some thousand yards of uncovered copper wire; I have at the present time only twelve layers on, and all seems to be going on perfectly, the spark is brilliant, and the shock, even from thin secondary wire without handles, is insupportable.

I must trouble you again in reference to the condenser. The one I had in use when using iron wire for the secondary coil does not act with the same primary wire and the same battery. The tin-foil is five feet by four inches, separated from a similar piece by varnished paper, and the alternate ends connected with the separate portions of the contact breaker, is it necessary in using a long thin wire for the secondary wire to construct the condenser in a different form by having it in several portions and collecting all the ends of each side respectively, and attaching them in the usual manner, or is it better to have it in one long length separated by the varnished paper? a word from you on this subject will be deemed a favour. What your correspondent means by my *particular views* of the science I am at a loss to understand, unless it be in endeavouring to procure a cheap source of electricity and the apparatus connected with it, and I certainly do not see anything so very absurd in that as to call for *his particular* remarks, and by one who does not understand what *compound* would be the result of the action of sulphuric acid on iron. In a future letter I shall be happy to give you a few remarks on the comparative merits of iron and copper wire for the secondary wire of the induction coil.—Yours respectfully, J. Cook.

* Hancock on India Rubber, pp. 58, 59.

[We much prefer the condenser constructed with a number of separate pieces of tinfoil; the alternate pieces being connected together on either side by means of a binding screw. We recommend you to saturate cartridge paper in white wax (spermaceti), and varnish three or four times. This gives a dielectric possessed of very high insulating properties.—Ed. E.]

AMALGAMATION OF ZINC PLATES.

To the Editor of The Electrician.

Sir,—I have lately tried a mode of amalgamating zinc plates, which is so rapid and effectual that it may not be unworthy the attention of some of your readers. Selecting the largest plate of the series of any particular battery, I cover it with stout brown paper, and upon this mould, with the fingers, a flat cell of sheet gutta percha softened in boiling water. A bell-mouth top is afterwards added, and when cold it is used by pouring in a small quantity of mercury and dilute acid.

When the zincs have been cleansed by acid in the usual way they have merely to be dipped successively into this vessel, which, by barely admitting them, causes the mercury to rise up their sides, instantly effecting the object in view. Plates can be finished in this way at the rate of ten per minute, and they should afterwards be ranged with one of their points downwards in a draining trough to collect the surplus mercury.

Your correspondent, "K. R. U." (whose mental equilibrium seems singularly affected by my last short letter), without denying the undesirability or presence of carbon in a wrought-iron positive, or even questioning the possibility of its extraction, as I stated, endeavours to persuade himself that I was seeking to render the metal "ultra-malleable," in order, I presume, to create something tangible whereon to found a sneer.

Again, I never stated that the mere incandescence of carbon particles would be sufficient to produce the electric light, but it must be known to everyone, "K. R. U., perhaps, excepted, that moving conductible particles of *some kind* are absolutely essential to its exhibition, and this being the case, I cannot see any very great absurdity in my suggestion, which therefore merits either a sound theoretical objection or practical trial.

Science has ever owed a considerable portion of its onward march to suggestions founded on theory, in spite of the argument-lacking "K. R. U." class of obstructors.

As his concluding observations tend to show that he considers the expense of a Ruhmkorff coil of greater moment than the value of a whale, or the lives of those engaged in his capture, I may safely dismiss both his logic and his simpler, though highly intelligent, process.—I am yours respectfully, H. T. (Bath).

"WIRE" AND "EARTH" CONDUCTION.

To the Editor of The Electrician.

Sir,—Will any of your correspondents explain *in detail* the various theories respecting the passage of the current along the wire and through the earth; or will any one tell me if the electric current is generally termed a fluid, if not, by what name is it generally called.—Yours respectfully, E.

[The "current" is electricity in motion through a conductor. The term fluid, though convenient and very generally used, is purely arbitrary.—Ed. E.]

Miscellanea.

The Telegraph in the Desert.—I confess that I lost sight of the black and white striped mile post with some regret. Hitherto we had travelled with these posts, and the telegraphic wires constantly on our right and left, as mute friends and companions. We could read the number of versts on each post when we had nothing else to do, and we could think of human messages going and coming on the wires; but now they are gone on far to the south, keeping company with travellers on the one good broad road that leads to Odessa.—*Russian Travel. All the Year Round.*

An apparatus for lighting gas by electricity was exhibited at the Franklin Institute, Philadelphia. The machine consists of a small glass disc, revolving between two pads of leather, and giving the generated electricity to points in communication with a brass rod about twelve inches long, terminating in a ball. An insulated handle is attached to the lower part of the instrument. A piece of wire, attached to a sheath which slips over the burner, is so adjusted that a spark given to it from the ball of the gas-lighter passes through the jet of flowing gas and instantly inflames it. The apparatus was manufactured by Messrs. Mitchell, Vance, and Co., of New York.

To Correspondents.

L. L. S. is requested to state what amount of work his electro-magnets are to perform, *i.e.*, the distance of the armature to be attracted, and the nature of the retaining spring.

*** In consequence of the great activity which at the present moment prevails in regard to telegraphic extension, we have been obliged to defer the appearance of several articles and communications of a scientific character.

†‡† Part V. of The Electrician is now ready, post free 1s. 6d.

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The Electrician.

Vol. I. No. 23.—April 11, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 255.]

148. In what has been hitherto said about *inductive atmospheres*, no account has been taken of the varying *densities of the air* by which charged conductors may be enveloped, and by which that particular state of things we are calling the artificial electrical equilibrium would be materially affected; independently of our belief that no truth relating to physical science can really be practically unimportant, although its utility may not be paramount, or at once apparent, we have a sufficient theoretical inducement for treating of variations in aërial density in the circumstance of their affording a *fifth* means for augmenting the charging capacities of insulated conductors, and by so doing, of furnishing additional comparisons between the results of doctrine and facts, thus more fully justifying our confidence in the new views of electrical action.

149. It seems almost superfluous to say that, as all the particles of air within a given distance of plus electricity on a conductor freely insulated in the atmosphere, contribute to receive its induction and lower the intensity of its action, we may by increasing or diminishing the numbers of aërial particles within that distance increase or diminish to a corresponding degree the quantity of plus charge, without in any manner changing its degree of intensity. Or, to give the case a more general expression, *as the air surrounding an insulated conductor is more or less dense, so also will be its charging capacity.* We can illustrate this experimentally.

Exp. 24. Fix a glass tube, with a wire cemented in its axis (in the manner described for making the gold leaf electrometer, par 84,) through a stuffing box in the crown of a capacious bell-glass receiver of an air-pump; stand upon the plate a large insulated conducting sphere, so proportioned and placed as to occupy the centre of the receiver, and be distant at least two inches from everything solid surrounding it, except the wire above, which is to touch it; put the outer extremity of that wire into conducting communication with one of the insulated cylinders, having the metallic leaf hanging against it, and communicate, by any convenient means, to the whole system of insulated conductors, a plus charge sufficient to cause the leaf to become very sensibly deflected. Part of the plus electricity, as we know must be the case under such circumstances, will pass from the cylinder through the wire of communication into the receiver, spreading over the surface of the sphere therein contained; and the quantity so received by the sphere will depend upon its charging capacity under an intensity of induction, indicated by the angle of divergence which the external metallic leaf forms with the surface from which it is suspended, for whatever be the relative quantities of charge on the several parts of the insulated conducting system, whether within or without the receiver, the intensity will be the same everywhere. Now if we diminish the charging capacity of any part of the system, it will be equivalent to our giving that part an increase of charge, and its consequence must be that to equalize the intensity a new distribution of plus electricity will ensue, attended by an elevation of intensity, making itself evident to sense by an increase of the deflection of the external metallic leaf. And we shall diminish the charging capacity of the inclosed sphere, if our theory be true, by withdrawing from around it a portion of its inductive atmosphere by the rarifying action of the air-pump, which in fact we find to be the case; for on proceeding to do this, we observe an increased deflection in the indicating leaf, proving that electricity is leaving the inclosed sphere, and passing outward to the cylinder, in order to maintain the balance of intensities under the altered relation of their charging capacities.

150. This experiment is sufficient for our purpose; it establishes the fact generally for which it has been devised; and, that being done, we have only to carry it out on acknowledged mechanical principles to perceive that the ratio of reduction, or increase, in the charging capacity of a conductor freely insulated in the air will simply correspond with the rate of diminution, or augmentation, of its density. No one can reasonably hesitate to believe that two particles of air can do just double of anything that one particle of air can do; and this, therefore, we shall hold to be true when air is sustaining electrical induction.

151. We must not hide from the student that, although this conclusion is so palpably inevitable on the common principles of mechanical philosophy, an impediment was once laid in the way of its adoption by Professor Faraday, who reported that it resulted from his experimental observations to believe that air, and the gases generally, support induction with equal effect, whatever be their densities. But the experiments from which this persuasion was derived have since been criticised in the light of a more efficient causation than at the time he had access to, when it was publicly proved that their indications had been misunderstood. We believe, though we have no warrant for asserting it, that the Professor no longer adheres to his original opinion; we may, therefore, be spared entering into particulars regarding the experiments to which we have alluded, and merely remark of them that the whole case is very illustrative of the facility with which even the most sagacious observers may be betrayed into false inferences from experiments, until they become acquainted upon mechanical principles with the causation by which they have been established.

152. We must now proceed to make a new calculation, which will, in principle, apply to conductors of all figures, but may be most conveniently initiated by the geometrical use of the spherical form. We need offer no apology for our frequent introduction of numbers and measures, because, in the first place, we use them only in a very simple and popular manner; and, in the second place, they afford a sure test by which such opinions as are purely speculative, can readily be distinguished from true conceptions of the electrical force, its simple action, and its manifold effects, as is indeed evidenced in our experience of them hitherto.

153. We shall go on in the hope that everything has been understood, and is remembered, that was said in our former papers about induction—that it is an attraction of electricity for common matter, or, which is the same thing, of common matter for electricity, whenever one of them has been detached from the other to which naturally it was united; that induction is a simple and inevitable consequence, not of electrical attraction in the abstract, but of the definite and limited character of electrical attraction; that by reason of the very nature of attraction induction must fall upon the appropriate materials most contiguous to the place where it is originated; that by reason of the electrical law of quantity, the intensity of induction becomes rapidly reduced to an insensible amount during its propagation from particle to particle, when it is diffused over constantly increasing quantities of aërial matter; that at every step of its progress induction is constant, by which we mean that the electricity and the common matter acting inductively upon one another are the same in quantity from first to last; and, finally, that the reaction opposed to induction at any place may be made to disappear by

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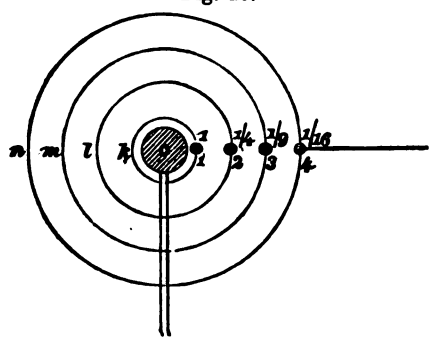
the escape of electricity, or the arrival of electricity, as the case may require, from or to conducting matter sustaining the inductive action.

154. In the hope, then, that our readers will have all this "at their fingers' ends," not as dogmatic assertion—not as gratuitous assumption—but as the rational and unavoidable conclusion of logical induction based upon our simple premises, we will proceed to our next business, which is to ascertain to what extent the induction of a charged conductor freely surrounded by the ordinary atmosphere, on an uninsulated one in its vicinity, and within range of its influence, will be affected by variations in their distance one from the other. Refer to fig. 3, in which we gave a diagram to represent at one view both the relative members of aërial particles at different distances increasing in arithmetical progression; and also the force of the induction sustained by each particle at these several distances; with that before us, let us multiply the numbers of particles at the several distances by the force of each particle there existing, and thus obtain the total forces of induction arriving at successive surfaces of air equidistant from one another. Beginning with $1\times1=1$, assumed to be the total force of induction on the aërial surface at an unit of distance, then $4\times\frac{1}{16}=\frac{1}{4}$ will be the force of induction on the total aërial surface at 2 units distance, $9\times\frac{1}{81}=\frac{1}{9}$ will be the total force at 3 units of distance, and $16\times\frac{1}{256}=\frac{1}{16}$ at 4 units of distance. Now, by a glance at these numbers, it will be seen that the total forces of induction arriving outwards from a central point to a series of equal consecutive distances, whether those distances be small or great, will be *for whole spherical surfaces of aërial particles there existing, as the squares of their distances inversely.*

155. To apply this deduction, let *a* (fig. 25) represent in sec-

Fig. 25.



tion a conducting ball fixed on the top of an insulating support of glass, and charged with plus electricity, whose inductive action extends to a sphere of aërial particles, the surface of which is denoted by the circular line *n*. Let the intermediate distance between *n* and the *centre* of the conductor be divided into four equal parts; there will result four concentric shells of air having spherical surfaces at *k l m n*; let *b* be a brass ball on the end of a straight uninsulating wire, by which it may be placed successively at the distances 1, 2, 3, and 4. Now, it is most important that we should know everything relating to the manner in which that uninsulated ball will be acted upon in those several positions. Thus much we know already, taught us by the case of the cylinders, that by virtue of its position, the ball will share in sustaining the induction that is arriving out so far (par. 124); and secondly, that the share it assumes to itself will be due both to its position and to its uninsulation (par. 138). We are sure, too, that the intensity of induction sustained by the ball must be in equilibrium with the aërial spherical intensity, for to become so the ball has only to go on dismissing into the earth consecutive portions of its own natural electricity, until all those that remain in it are held by forces of attraction as great at least as the aërial intensity. The quantities dismissed, therefore, will necessarily bear a definite proportion to the dismissing forces at all the several distances at which the uninsulated ball may be placed; and accordingly be, in conformity to the electrical law of quantity, as the square roots of the several spherical intensities. This being so, it follows that as at the distances 1, 2, 3, and 4, the whole spherical surfaces have intensities varying as the numbers, 1, $\frac{1}{4}$, $\frac{1}{9}$, and $\frac{1}{16}$, so the quantities of electricity dismissed at those several distances will be at one unit of distance 1, at two units of distance $\frac{1}{2}$, at three units of distance $\frac{1}{3}$, and at four units of distance $\frac{1}{4}$; because by the law of quantity $\frac{1}{2}$ acts with only $\frac{1}{4}$th the intensity of 1, $\frac{1}{3}$rd with $\frac{1}{9}$th the intensity of 1, and $\frac{1}{4}$th with $\frac{1}{16}$th part of the intensity of 1.

156. These deductions, as we will show in our next, are perfectly in correspondence with facts; it is quite well known that electrical attraction between two flat surfaces exposed to the air, one charged and the other uninsulated, varies in force as the inverse squares of the distances; and that fact has been received as teaching that electricity projects its force through space according to that particular ratio. Whether it do so or not we leave for future investigation; our present purpose is to demonstrate that the inverse squares of the distances result from the electrical law of quantity, irrespective of distance. We cannot too strongly impress upon the student's mind the propriety of studying well the explanations that law has enabled us to give of contiguous induction, and we recommend him to carry out the latter subject into all its details rather than confine it to the examples we have given; to aid him in doing so, we import into this place two tables, replete with suggestions for theoretical exercises, and to which he may at all times find it convenient to refer.

Table I.,

Of aërial induction in an atmosphere of any given density.

Elect.	a	Dist.	b	c	d	e
Units of plus charge in action.	Intensities of plus charges on any given quantity of common matter. Elect.ª	Distances of spherical shells from common centre.	Surface and relative numbers of common atoms submitted to the inductive action. Dist.²	Intensities of a given plus charge on each common atom in spherical shells at different distances. $\frac{256\ (=\text{unity})}{ds}$	Total forces of a given plus charge on any whole spherical surface at different distances. $b\times c$	Intensities on each common atom in spherical shells whose distances increase with the charges in arithmetical progression.	Total forces on spherical shells when the plus charges and the distances both increase in arithmetical progression. $a\times d$
1 =	1	1 =	1	256	256 = 16	16	256
2 =	4	2 =	4	16	64 = 4	4	256
3 =	9	3 =	9	$28\frac{4}{9}$	$256 = 16$	$1\frac{7}{9}$	256
4 =	16	4 =	16	1	16 = 1	1	256

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157. We will give an example of the manner of using this table:—suppose we require to know what resistances to induction are opposed by a particle of the surrounding air at various distances from a given charge; selecting an unit of charge (1st col.), its intensity being an unit (col. *a*), will at an unit of distance (3rd col.), fall upon an unit of air (col. *b*); under these circumstances, let us call the resistance of the air 256 (col. *c*); then extending the induction to 2 units of distances, we shall have 4 particles of air to sustain it; in that case the quantity of charge acting on a particle will be $1 \div 4$, and its resistance $256 \div 16$ (the square of 4); and so with other distances. In like manner, the student may exercise himself by varying the quantities of charge, while the distance remains constant; or by making both terms vary together.

Table II.,

Of aërial induction in atmospheres of variable density.

Elect.	Dens.			
Units of plus charge in action.	Intensities of plus charges on any given quantity of common matter. Elect.^{2}	Aërial densities and relative numbers of common atoms submitted to the inductive action.[1]	Intensities of a given plus charge on each common atom at varying densities. $\frac{16\ (=\text{unity})}{\text{dens.}^2}$	Total forces of a given plus charge on any whole spherical surface at varying densities. dens. × *b*.
1 =	1	1	16	16
2 =	4	2	4	8
3 =	9	3	1¾	5¼
4 =	16	4	1	4

a	*b*	*c*	*d*
Intensities on each common atom when the plus charges and the densities both increase in arithmetical progression. *a* × *b*.	Total forces on spherical shells when the plus charges and the densities both increase in arithmetical progression. dens. × *d*		
1	16=1		
16	32=2		
16	48=3		
16	64=4		

It will be perceived that the latter table has been calculated for only one distance, as the former was for a constant density.

(*To be continued.*)

GUTTA PERCHA *VERSUS* CAOUTCHOUC.

We have been considerably mystified—to use a transatlantic expression, by the letter of the Right Hon. Stuart Wortley which appeared in the *Times* of the 3rd inst. As a member of the Government Commission appointed to inquire into the construction of submarine telegraph cables, the chairman of the Atlantic Telegraph Company must be *ex officio* an excellent authority upon a question involving the nature of the results obtained by this Commission. Standing in this position, Mr. Stuart Wortley unhesitatingly asserts that the result of the labours of the Commission was to shew that "except under very exceptional circumstances"—probably those in which a cable would be exposed to a temperature approaching 112° Fah., "gutta percha is the best insulator." We are possessed of all due deference towards such an authority, and hence our mystification; for the careful perusal and study of the valuable collection of facts and opinions in the Government Report, had given to us, and doubtless to most of our readers, an impression that this Report had established, as far as experimental trial extends, the superiority of caoutchouc to gutta percha as an insulator for telegraph cables. We have been ready to concede their full measure of importance to the prudential considerations in which the use of an untried material is deprecated; but we could scarcely have questioned the conclusions as to the abstract comparative merits of caoutchouc as an insulator, and we looked forward with some amount of anticipation to its trial upon a larger scale than heretofore.

When we find these merits not only questioned, but confidently denied, by a "member of the Commission," we naturally feel puzzled and disconcerted; and we can only console ourselves *par le malheur d'antrui*, in reflecting upon the difficult position of the other "members of the Commission" whose printed Report has been so long before us. We have in vain again looked through this Report for an adequate basis upon which the assertion from such a source can be founded; and we can only, with the Roman poet, exclaim

"Felix qui rerum potuit cognoscere causas!"

The statements in the Government Report relative to the two insulators are sufficiently clear and unmistakable. In the "summary of principles which should govern the constitution and laying of submarine cables," we find:—"Of all the materials which have been submitted to us the best insulator by far is india rubber; Wray's compound and *pure* gutta percha nearly resemble india rubber in its insulating property." We need scarcely observe that Wray's compound contains caoutchouc, and that the "pure gutta percha" referred to is not a material which is practically available for insulation upon a large scale. Again, "India rubber surpasses all other materials in the smallness of the amount of its inductive discharge, and the perfection of its insulation." But our readers will find the whole summary of principles by referring to page 175 of this journal. We would scarcely ourselves express so unqualified an approval of india rubber as that which is contained in the substance of this summary. We have looked upon the expediency of its adoption in so enormous a venture as an Atlantic cable as a question which is practically undecided, *in spite of* Mr. West's celebrated wire across Portsmouth Harbour, the submarine wires of Professor Jacobi in Russia, and the results obtained by the Government Committee. But when such an authority as the Chairman of the Atlantic Telegraph Company appeals to these results for evidence of the superiority of gutta percha over cautchouc as an insulator, we feel bound to express our dissent from his views, and our surprise that such views should have found expression.

But Mr. Wortley's letter is illogical as well as unjustifiable in other respects. He states, that "so far from gutta percha having failed in submarine lines, he need only refer to the fact that in nearly all the sea-going and oceanic lines now submerged and in efficient working, that substance alone is used." This would be a very forcible illustration of the superior value of gutta percha *providing* other materials had been to any extent used for insulators, and had failed in greater degree than the insulator in question. As it is, the lines extant are found to be insulated with gutta percha simply because this has been the only material used both for these lines and for those which have failed. Again, gutta percha is considered the best insulator, "as it was proved to be impermeable to sea or fresh water under a pressure of twenty-thousand pounds to the square inch." This also would be conclusive as to the relative value of gutta percha, notwithstanding any other points of disparity, if it could be shown that under an equal pressure, india rubber becomes permeable to water. But what are the facts upon which the assumption is based? When immersed, gutta percha, india

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rubber, and other insulators absorb a portion of water. In sea water, under pressure, the absorption by gutta percha is almost *nil*, that of caoutchouc is always sensible, but only reaches to a small depth, and does not in any way impair the insulating power of that portion of caoutchouc which is beneath the moistened layer. The insulation of the specimens of gutta percha and of the masticated india rubber experimented upon by Professor Miller was in no way impaired by immersion under pressure, though the results with virgin india rubber, supplied specially at the request of the Professor, were not equally satisfactory.* Turning to the Appendix to the Report,which gives the details of the experiments in question, we find that the following wires were submitted during a period of six weeks to a pressure of three tons on the square inch in sea water, and tested by the electrometer under a charge of 42°, viz.:—

No. 1. Gutta percha covered (Gutta Percha Company).
No. 2. Ditto ditto ditto.
No. 3. Ditto ditto (West Ham Company).
No. 4. (Silver and Co.) masticated caoutchouc.
No. 5. (Hall and Wells) ditto.
No. 6. (Ditto) virgin rubber.

The results were as follows:—

No. 1.	Loss of insulation	in 1 hour 17 min.....	12°.
No. 2.	Ditto	in 2 hours 39 min.	12°.
No. 3.	Ditto	in 43 min..... .	12°.
No. 4.	Ditto	in 21 hours	2·45°.
		in 37 hours 10 min.....	4°.
No. 5.	Ditto	in 24 hours 20 min.....	2·45°.
		in 30 hours	4°.
No. 6.	The loss of insulation too great to sustain full tension.		

We leave our readers to judge whether caoutchouc in the form in which it would be generally used, viz., after mastication, compares favourably with gutta percha as an insulator under great pressure of water. Those who were enabled to follow closely the results obtained by the Government Commission may be aware that, owing to the want of precautions, which were subsequently found necessary, there was at one time considerable risk of the merits of caoutchouc, as an insulator, being ignored. It would almost appear as if Mr. Stuart Wortley had given his attention to these results up to a certain point, and had then lost sight of the ultimate conclusions adopted by those members of the Committee who attached their signatures to the Report.

THE "*TIMES*" ON SUBMARINE TELEGRAPHS.

We know not whether among the galaxy of talent which coruscates in Printing House Square there glimmers any particular star devoted to the illumination of the world on science in general, or electricity in particular. The profound ignorance which characterizes the quasi-scientific articles, which from time to time make their appearance in the great journal, would in charity however lead to a negative inference in this respect. On the subject of telegraphy especially, the absence of all useful information is as marked as the palpable distortion of fact; and the positive tone in which error is propagated is only equalled by the strange ill-nature which ever pervades the columns of the *Times* when writing upon ocean telegraphy.

During the past week an article appeared in that paper on the important question of the Telegraph to America, in the course of which the writer introduces with a great flourish the very questionable fact that the difficulty of working through long circuits, owing to the retarding influence of induction, increases in about the square of the length of the line, when long insulated wires are laid either in earth or under water. It will be remembered by those who have perused the able report of Mr. Latimer Clark, given in the Appendix to the Government Report, that the results of actual experiment† are adverse to this theoretical conclusion. The *Times* writer, however, proceeds to make use of this quasi fact, in the following ingenious manner, as against the Atlantic Company, who are trying to resuscitate their original line between Ireland and Newfoundland. He says, "Thus it is that if two lines of the same dimensions and cost, as regards copper and insulation, were laid—one for 500 miles, and the other for 1,500 miles, the former could be worked through for messages at nearly *nine times the speed of the latter!!*" Here all the improvements of the last four years are ignored or known nothing of; all the possible modifications of a law which has only been advanced as a point of theory are kept out of sight, and the recent statements published by Mr. Varley, Professor Thomson, Messrs. Forde and Fleeming Jenkin, and Mr. Allan to the effect that a line containing 510 pounds of copper and 550 pounds of gutta percha per mile, can be worked between Ireland and Newfoundland, at from 8 to 12 words per minute, are either totally disregarded, or else we are invited to believe that the pet line of the *Times* will work at the rate of 108 words per minute! We cannot think, however, that the latter could be meant; as even the best constructed *land lines* we have ever known could not in practice be worked by the most rapid manipulators at a greater speed than 20 words per minute continuously.

The premises of this writer being thus fallacious, the following deduction equally comes to nothing. He says *ex cathedrâ*, "Hence a line laid in sections must always possess immense advantages over long unbroken circuits."

Does he not know that working through long lines of cable by relay between section and section is practically useless—as is found already in the case of the Malta and Alexandria line, where the longest section contains only 600 miles of cable? The relays have to be so delicate that they cannot be kept in adjustment, and the consequence is that far more time is lost than would be the case if the line were worked in direct circuit. How then would it fare with the line between Greenland and Iceland, which, including slack, will not measure less than 960 nautical miles, and with the line between Greenland and Labrador, which will measure, including slack, 720 nautical miles? The fact is, that in these two cases, the relay system would be utterly useless and inapplicable, and the only way in which the line could be worked would be by reading off the messages at every stopping place, and retransmitting them. The whole work of sending a message between Scotland and Labrador would thus have to be performed four times over, and beside this, the separate retardation of the four sections must be added together, and would be nearly equivalent to the retardation due to the total length of 2,310 miles of sea line proposed to be laid by the North Atlantic Telegraph Company.

The consequence would be, that the North Atlantic line must work much slower in practice than the direct line between Ireland and Newfoundland, notwithstanding the specious appearance which it presents at first sight to a non-scientific mind.

We say nothing of the enormous difficulty and expense, of which the *Times* writer speaks so lightly—of constructing and maintaining in order land lines of 150 miles across volcanic Iceland, where not a tree nor shrub exists, and across the continent of Labrador—the most stormy and frightful climate in the world. We must however again question his discretion when, in speaking of the sea sections, he says, that "the sections if injured or destroyed, could be easily replaced or repaired." The fact as to the facility for repairs is, that the coasts of either Greenland or Labrador are only approachable for about six weeks of the year; and as to losing a section now and then, although it seems to be accepted as a probability, and is so lightly thought of, we cannot but notice, on brushing up our arithmetic, that nine hundred and sixty miles of cable, at the minimum cost of £200 per mile, amounts to £192,000; a loss that would not bear repetition even by a more flourishing undertaking than the North Atlantic Telegraph. Finally, the *Times* reasons that "as it is highly *improbable*, almost *impossible*, in fact, that all four sections would get

* Government Report, p. xx., quoted in The Electrician, p. 65
† See Government Report, p. 325.

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out of order at once," the communication cannot be totally interrupted! Suppose Greenland could not communicate with Labrador, or Iceland with Greenland, does he mean to say that the line would in that case, or in case of any other section being out of order, be able to communicate between Europe and America? Nay, take even the case of the land line in Labrador being injured, which would certainly be a thing of daily occurrence in the stormy season, of what use would any portion of the line be?

The fact is that, on the most careful consideration, the North Atlantic scheme appears far less practicable than that which has again been placed before the public by the Atlantic Company with a confidence which at this period is fully warranted by the immense progress which has taken place in the science of electro-telegraphy.

SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

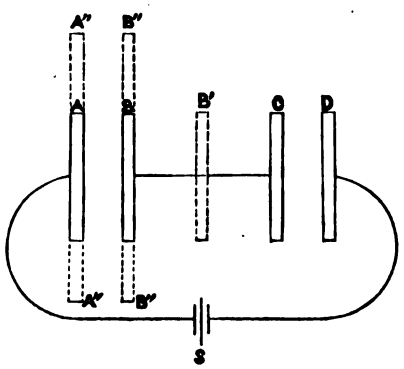
BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 245.]

It has already been briefly stated, in order to explain the effect of *halving* the resistance of the inductive circuit, that in any inductive circuit the accumulation depends on the sum of all the successive resistances in the circuit, and as the quantities on the opposing surfaces are constantly equal, it follows that an alteration of any one resistance in the circuit affects the accumulation on all the surfaces throughout the entire circuit. We have now to consider this effect a little more in detail.

Let us suppose A, B, C and D (fig. 49), to be four equal plates, B and C being joined by a conductor, and C and D being connected each to opposite poles of a source S, let the distance between A and B equal that between C and D, and, in accordance with the hypothesis we have laid down, let it be supposed that they are so far removed from all surrounding conductors that the inductive action will take place practically entirely between their opposing surfaces, so that the total quantity on each plate will be but little different to that due to the direct action between them. We have thus an inductive circuit more apparent to the eye and more resembling the conductive circuit than those which invariably exist, but in a more disguised and complicated form, in all cases of electrical accumulation.

Fig. 49.



The plates A, B, C, and D, will have equal quantities disposed on each plate, and as their surfaces are all equal, the density $\left(\text{or } \frac{\text{quantity}}{\text{surface}}\right)$ on each will be equal. If now after having discharged the plates, B be removed to B', double its former distance from A, then the resistance between A and B will be evidently doubled, whilst the resistance between C and D remains unaltered The resistance of the induction circuit is increased, and the accumulation on each plate will therefore be decreased, as the total inductive resistance is increased. The quantity on each plate is less than before, but still equal on all, and as the surface of each is the same, the density is equal on all the plates, though less than before B was removed to B'.

As it has been stated that any prismatic inductive resistance is inversely as the sectional area, and directly as the length, the total resistance of an inductive circuit may be decreased, either by decreasing the distance between one of the pairs of plates, or by increasing their surface.

Thus, if A and B be increased m times in surface to A'' and B'', without altering the distance which separates them, then the inductive resistance between these plates will be decreased m times, and the resistance of the whole circuit is consequently decreased, and the quantity accumulated on each plate therefore increased.

The density on C and D will therefore rise, for we have a greater quantity on the same surface; but the density on A'' and B'' will have decreased. For since the plates A and B are increased m times in surface, the density on them could only remain unaltered by the quantity accumulated on each plate being increased m times; but this could only take place if the *total* resistance of the circuit were decreased m times, and since it is only a *part* of the total resistance of the circuit which is decreased m times, whilst the remainder remains unaltered, the total resistance cannot be increased so much as m times; the quantity accumulated cannot have been increased m times, and therefore the density on A'' and B'' must have decreased.

Let r = resistance between A and B, and r' = resistance between C and D, and let $r = r'$; let s = surface of any of the plates, all being equal; then the resistance of the inductive circuit is expressed by—

$$R = r + r'.$$

If now the plates A and B be increased in size m times, the total resistance will be expressed by—

$$R' = \frac{r}{m} + r'. \qquad (1)$$

If Q = the quantity on each plate before A and B were increased, and Q' the quantity on each plate when A and B are increased, then—

$$\frac{r}{m} + r' : r + r' :: Q : Q'.$$

$$\text{or, } Q' = \frac{Q\,(r + r')}{\frac{r}{m} + r'} = \frac{Q\,(r + r')\,m.}{r + m\,r'} \qquad (2)$$

If m is infinite, then evidently $\frac{r}{m} = o$, and since also $r = r'$, the equation will become $Q' = \frac{Q\,2\,r}{r} = 2\,Q$.

Q' is therefore always greater than Q, but can never equal 2 Q, until m is infinite; and as Q' always increases when m is increased, but is never equal to 2 Q, it cannot increase in the same ratio as m.

The density before A and B were increased would be $\frac{Q}{s}$ on all the plates; and on A and B increased m times, $\frac{Q'}{m\,s}$; and on C and D after A and B were increased, $\frac{Q'}{s}$.

But since Q' never increases in the same ratio as m, $\frac{Q'}{m\,s}$ must always be less than $\frac{Q}{s}$, and must constantly decrease as m is increased, or the density on the plates A and B decreases as they are increased in size.

And as Q' is always greater than Q, $\frac{Q'}{s}$ must be always greater than $\frac{Q}{s}$, or the density on the plates C and D is always greater when A and B are increased; and as Q' always increases when

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m is increased, $\frac{Q'}{s}$ always increases when m is increased, or the density on the plates C and D always rises when the plates A and B are increased; but as Q′ can never equal 2 Q, $\frac{Q'}{s}$ can never $= \frac{2\,Q}{s}$ or the density on the plates C and D can never be doubled, however much the plates A and B be increased, unless infinitely increased.

Thus, if $r = 6$, and $Q = 10$,
$r' = 6$, $s = 5$,
$R = 12$, $m = 2$,
then D, or density on all the plates before A and B are altered, will be $\frac{10}{5} = 2$.

If A and B are increased m times their surface, then—

$$Q' = \frac{10 \times 12 \times 2}{6 + (2 \times 6)} = 13{\cdot}3.$$

Therefore, D′, or density on A and B increased m times to A′ and B′, will be $\frac{13{\cdot}3}{10} = 1{\cdot}33$; and d', or density on B and C, when A and B are increased m times, $\frac{13{\cdot}3}{5} = 2{\cdot}66$.

The following are a few calculated values for Q′, D′ and d', when m is that number expressed in the first column, the other quantities remaining the same as given above.

m.	Q′.	D′.	d'	D′+d'.
1	10·0000	2·0000	2·0000	4·0000
2	13·3333	1·3333	2·6666	3·9999
5	16·6666	·6666	3·3333	3·9999
10	18·1818	·3636	3·6363	3·9999
20	19·0476	·1904	3·8095	3·9999
100	19·8019	·0396	3·9603	3·9999
1000	19·9800	·0039	3·9960	3·9999

It will be seen that the densities on the two sets of plates are always such that their sum is double* that on either pair before the one pair were altered; so that when the density on the one set is decreased to *nil*, by the plates being infinitely extended or touched together, the density on the remaining pair will be exactly double what it was when all the plates were equal.

We have supposed in the above, that the two pairs of plates (A, B, and C, D), were equal and equidistant before the one pair were increased in size, so that r was equal to r'.

If one of the pairs of plates, as A and B′, are separated, in the first instance, a greater distance from one another than the other pair, C and D, so that r is greater than r'; then if the plates A and B′ are increased in size infinitely, r will be destroyed and Q′ will be found by the proportion—

$r' : r + r' :: Q : Q'$.

$$\text{or, } Q' = \frac{Q\,(r + r')}{r'}. \qquad (3)$$

but as r is greater than r', $\frac{Q\,(r + r')}{r'}$ is greater than $\frac{Q\,2\,r'}{r'}$, or 2 Q and Q′ is greater than 2 Q. Consequently if the plates A and B′ be continually increased in size, there will be some sizes at which the quantity on each of the plates will be doubled; or in fact some value of m, to which, if the plates of r be increased, Q′ will equal 2 Q.

* As near as four places of decimals will give.

Now, $Q' = 2\,Q$ when $\frac{m}{r} + r' : r + r' :: 1 : 2$,

or when $\frac{r + r'}{\frac{r}{m} + r'} = 2$,

$$2\left(\frac{r}{m} + r\right) = r + r',$$

$$\frac{r}{m} + r' = r + r',$$

$$\frac{r}{m} = \frac{r + r'}{2} - r',$$

or when $m = \frac{r}{\left(\frac{r + r'}{2}\right) - r'}$, (4)

Thus if $r = 8$, $r' = 3$, and $Q = 10$; then if r be reduced to nil by the plates A and B being infinitely extended or touched together.

$Q' = \frac{10 \times 11}{3} = 36{\cdot}6$, which is the greatest quantity that can be produced on the plates C and D by an infinite increase of the plates A and B. And to increase A and B so that the quantity Q′ on C and D shall be double Q,

$$m \text{ must equal } \frac{8}{\frac{8+3}{2} - 3} = 3{\cdot}2,$$

or the plates A and B must be increased 3·2 times in surface, when by equation 1 we get

$$Q' = \frac{10 \times 11 \times 3{\cdot}2}{8 + (3 \times 3{\cdot}2)} = \frac{352}{17{\cdot}6} = 20.$$

By substituting for the value 2 in equation 4, any other value x less than $\frac{r + r'}{r'}$, we can obtain such a value of m that if the plates A and B are increased m times, the quantity on C and D will be increased x times.

Thus, $\frac{r + r'}{r'} = 3{\cdot}66$, which is the limit to which we can multiply the quantity on C and D by any increase of A and B. But if we wish to multiply the quantity on C and D by any number less than 3·66, as for instance 2·9, then by equation 4—

$$m = \left(\frac{8}{\frac{r + r'}{2{\cdot}9} - r}\right) = \left(\frac{8}{\frac{8+3}{2{\cdot}9}}\right) - 3 = 10{\cdot}1$$

or the plates C and D must be increased 10·1 times in surface, when

$$Q' = \frac{10 \times 11 \times 10{\cdot}1}{8 + (3 \times 10{\cdot}1)} = \frac{1111{\cdot}0}{38{\cdot}3} = 29{\cdot}0.$$

If the plates A and B are closer than C and D, and consequently r is less than r', then if r is destroyed, in the same way it can be shown that Q′ will not be so great as 2 Q, and consequently no increase of the plates A and B can double the quantity on the plates.

If, in the case of the equal and equidistant plates, after the plates A and B have been increased m times, and the quantity Q consequently obtained on each plate, the plates C and D are increased m times, then since each of the resistances have been decreased m times, the total resistance of the circuit is decreased m times, and the quantity increased m times, or

$$Q'' = Q\,m.$$

And the density on all the plates is therefore $\frac{m\,Q}{m\,S} = \frac{Q}{S}$, or the same as before they were increased; but it has been shown that when A and B were alone increased, the density on them was less than $\frac{Q}{S}$, and that the density on C and D was greater than $\frac{Q}{S}$; the density on A and B has therefore increased by increasing C

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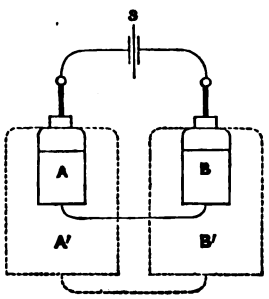
and D, whilst that on C and D has decreased until both are equal.

When one pair out of four equal and equidistant plates are increased in size, therefore, the density on the increased plates falls, whilst that on the unaltered plates rises.

If now the smaller pair of plates be increased in size, the quantity on both pairs will rise, the density on the smaller falling, whilst the density on the larger ones will rise, until when both pairs of plates are of equal size, the density on both will be equal, and equal to the density on both pair before either were increased; the total quantity being now increased proportionately to the total decrease in the inductive resistance. Thus, if both pairs of plates have been increased m times, the inductive resistance has been decreased m times, and the quantity accumulated increased m times; but as the surface has been increased m times, the density is the same as before the increase of sizes took place.

In the same manner, if two equal Leyden jars, A and B (fig. 50), have their interiors connected to the two poles of a source, S, whilst their exteriors are connected together, an inductive circuit will be formed, and the quantity accumulated in each jar will be equal, and since their surface is the same, the density will be the same in each. If now B be increased in surface to B′, without altering the thickness of the glass (A remaining unaltered), the total inductive resistance will be decreased, and the *quantity* accumulated in each will be increased; but whilst the density of A rises, the density of B will have decreased.

Fig. 50.



If A be now increased in surface to A′ (B′ remaining unaltered), the total quantity will again rise, but the density in A will decrease, whilst that in B′ will rise until when A′ = B′, the density and quantity is the same in both. The sum of the quantities in A′ and B′ will now be as much greater than that which previously existed in A and B as the surface of the two larger jars exceeds that of the smaller pair, and the density will be the same as before either were increased.*

(To be continued.)

RANDOM PAPERS BY A PRACTICAL MAN.

IV.—Gutta Percha and India Rubber Joints.

The weakest point of an insulated wire, submerged in the sea, buried in the earth, or immured in a tunnel, is the joint. It is the first point to give way—the first to show weakness. Its construction is the operation upon which the greatest care should be exercised, and it is one of those duties which should be entrusted to none but the most experienced and reliable hands. The life and soul of a submarine cable lies in the perfection of the joints. I wish I could depict, for the edification of your readers, some of the joints that I have seen. I could make their hair stand on end. I will, however, rather show how a good joint should be made, than dwell upon the scandalous jobs and villainous scampings that have so shamefully retarded the progress of submarine telegraphy.

And first with regard to the copper wire, which is common both to gutta percha and india rubber.

The joint made by the Gutta Percha Company is shown in fig. 1.

Fig. 1.

The wire is first scarfed, tinned, and carefully soldered. It is then lapped with very fine copper wire (about guage No. 24), and again soldered. It has finally a second lapping of fine wire, which is only soldered at the extremities, so that if the joint give way, the electrical continuity will be maintained by the fine wire. The same joint is adopted by this Company for stranded as well as solid wire.

In wire for underground and land purposes, this second lapping is dispensed with.

This joint is by no means as strong as the wire itself, and therefore lacks the first requisite of a perfect joint. It is, however, complete in every other quality. I have known many instances where these joints have given way under severe strain, although the continuity has been always maintained by the fine wire.

A splice in the stranded wire would be considerably stronger, and quite as easily made.

The fine wire joint is almost invariably adopted for submarine purposes, but is dispensed with on land. The joint fig. 2 has been much

Fig. 2.

used; but that most frequently employed is the following.

Fig. 3.

It is a perfect joint, and has not the disadvantage, which a similar joint of iron wire possesses, of being weakened by the torsion applied to it.

The number of turns of each wire around the other varies with the whim of the jointers. One is quite sufficient for all practical purposes. I have drawn four as being more generally used.

I have never seen an instance of this copper wire joint failing. I wish I could say the same of the insulating medium.

Having made the joint in the copper wire, the wire and the gutta percha are gently warmed with the spirit lamp, and the gutta percha is tapered over the bare wire until the ends nearly meet. It is then again warmed, and a strip of thin gutta percha sheet, about ⅜ in. wide, wound spirally around it. This is carefully pressed down, again warmed, and a fresh ribbon of gutta percha applied in the reverse direction. This process is repeated until the proper thickness is attained, and the joint is carefully finished off with a warm tool. The old and new material must be carefully kneaded together at the point of juncture. Each layer of gutta percha should overlap the one below it. These thin strips must be carefully kept clean and dry in a small box constructed for the purpose.

Moisture, grease, tar, dirt, &c., must be carefully avoided; and above all things, the gutta percha must not be burnt. All these things are opposed to that adhesion, which is necessary to make the joint homogeneous. I always insist upon the joint being carefully wiped, before the application of the thin strips of gutta percha, with rectified *coal naphtha*. It removes all extraneous matter, and, by slightly dissolving the surface of the gum, considerably assists adhesion.

Gutta percha when in dry positions shrinks. If there be not perfect adhesion between the main covering of the wire and the sheet percha the joint opens out.

Bad joints are always the result of dirt, careless application of the strips, burnt gutta percha, and *dirty hands*. Cleanliness is essential to success. The fingers, which are always greasy, should be used as little as possible, and the kneading and finishing off effected with the proper tools supplied for the purpose.

Formerly two thicknesses of gutta percha were employed, viz., a sheet about ⅛ in. thick, and the thin sheet. The thick sheet was applied first, and carefully kneaded with a tool constructed for the purpose; but experience has shown that a better joint can be made with the thin sheet alone, and therefore the thick sheet has been generally abandoned.

India rubber covered joints are made in the same way, with the exception that every layer of sheet rubber is well saturated with

* These considerations are of considerable interest when dealing with the charges of unequal lengths of submarine cables of similar pattern, attached to the two poles of a battery, and I have therefore illustrated this problem geometrically towards the end of the essay.

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benzine, or which is equally effective, *rectified coal naphtha*. The joint is thus formed into a homogeneous mass, as firm and efficient as any portion of the original wire.

Gutta percha joints are frequently covered with a wrapping of sheet rubber, extending about two inches on each side of the joint, which acts as a preservative to the gutta percha, and prevents that evaporation which is so destructive to that gum. It should always be adopted in tunnels and places where evaporation may occur. It is wrapped on cold with coal naphtha.

Gutta percha and india rubber joints fail more from the want of adhesion between the old and new stuff than from any other cause; but if the use of *coal naphtha*, or *benzine*, which is only a more purified solution of the former material, be adopted, this cause of failure will be considerably reduced.

It sometimes happens that gutta percha has to be united to india rubber. An excellent joint can be made by the use of coal naphtha, using rubber strips.

The proper man to make a joint is the man to whose care the maintenance of the wire has been entrusted. He alone will devote to it that care and that attention which are essential to durability and efficiency. An occasional hand, even if an old experienced jointer, will make a very good looking joint: but it is only the former man who will give it that solidity and adhesiveness which will render it permanent and innocuous.

"DEFLECTIONS" OR EARTH CURRENTS.

Telegraph clerks seem to be impressed with the opinion that "deflections" are produced by changes of weather. A very little consideration would show, that if weather were the cause, they would appear much more frequently than they do.

The Rev. H. Lloyd, of Trinity College, Dublin, supplied a paper on the subject to the Transactions of the Royal Irish Academy, in November of last year; I will endeavour to give a sketch of it.

I must first remind beginners that the compass needle is subject to a small daily variation, that is, it does not point in exactly the same direction at all hours. This variation obeys a regular fixed law. There are also times when its direction is very much affected, not in obedience to the ordinary law, but irregularly. This irregularity is caused by what are called "magnetic storms." Dr. Lloyd states that as soon as Oersted had pointed out the connection between current electricity and magnetism the idea occurred to many that the daily fluctuation of the direction of the compass was the result of currents traversing the earth's crust.

In May, 1847, Mr. W. H. Barlow, the engineer of the Midland Railway, connected galvanometers to two spare telegraph wires which were observed every five minutes day and night for a fortnight. These observations proved that a wire connected with the earth at two distant points is unceasingly traversed by electric currents, the strength of which depends on the direction of a line drawn from one earth plate to the other, and is entirely independent of the course of the wire itself, however circuitous.

These currents cease as soon as one of the earth connections is removed, clearly showing that they are not due to atmospheric electricity, but are currents passing through the crust of the earth, a portion of which is conveyed along the wire. He did not, however, succeed in showing that the deflection of the galvanometer needle coincided with the daily variation of the compass.

Taking advantage of the progress made during the fourteen years which have elapsed since these observations were recorded, Dr. Lloyd has calculated their results, compared them with the records of observations on the compass needle, and has clearly proved from them, that the regular daily variation of the compass does coincide with the strength and direction of the current acting on a galvanometer attached to a telegraph wire. He considers that the earth is acted on to a considerable depth by the currents which sweep over its surface, which alter by induction the magnetism of the subjacent mass, and that the effect produced on the compass needle or freely suspended magnet, is the result of this change of magnetic condition.

In the early hours of morning, from 1 to 6, the direction of the current changes little, its direction is then 21° to the west of north.

At 7 a.m. it begins to move eastward, and becomes due north at 7.15 a.m. At 10.25 a.m its direction is E. At 3.15 p.m. it becomes S., and at 7.35 p.m. it is W. Finally, after midnight, it reaches its stationary position to the W. of N.

The current has a maximum intensity at 1 and 7 p.m. The point to which the earth current is directed follows the sun, although at unequal intervals at the different periods of the day.

The shape of the coast line in places near the sea, the proximity of mountain chains or strata of bad conductors, will greatly influence the general direction of the daily regular current.

I would add a few remarks to this hasty glance at Dr. Lloyd's valuable paper.

We have as yet considered the daily variation of the compass needle and the regular daily currents of the telegraph; let us now speak of the "*deflections*" of the telegraph service and the "magnetic storms" of the observatory.

Whenever deflections have occurred the observatories have noticed unusual disturbances of their suspended magnets. The Aurora affects both the telegraph and the compass, so much so, that a telegraph clerk may safely say when an aurora will be visible. This shows that both phenomena are due to the same cause.

It has been observed that one line of telegraph will be most affected when deflections occur in the morning, another when they occur in the afternoon, and that they may now and then be seen leaving one circuit to appear on another. Records have not been generally kept; but sufficient is recorded to show that it is probable that the direction of these irregular currents obeys the same law as those regular currents observed by Mr. Barlow, and it would be very interesting if the intelligent members of the telegraph staff would record during deflections, which circuits were *most affected*, say every hour while the deflections lasted, and particularly to notice any case of their ceasing permanently on one wire and commencing to appear on another.

Lest any one should say there is no practical value in taking notice of such troublesome visitants, let me say that the study of them has led to two rather useful practical rules for keeping communication open which might otherwise be stopped.

1. When you have more than one circuit between two places, suspend one of them and use it as a return wire for the other.

2. If there are two circuits in different directions, in which the deflections are in opposite directions, *i. e.* the current in one + and in the other —. If the earth is taken off at the joint stations, and the two circuits connected *through*, the wire will become free or nearly so, and you can work both.

R. S. Culley.

LYMINGTON LITERARY INSTITUTION.

On Tuesday evening the members of the Literary Institution had a high treat in Mr. Preece's able lecture on "The Electric Telegraph." During the whole of the day various notions were afloat as to the nature and uses of the wires stretching from the railway station to the institution, very few of them however hitting the mark. About four o'clock in the afternoon the rain came down in starts and splashes, till six o'clock in the evening, when it settled down into a regular heavy drenching discharge, and continued so till after midnight. Consequently, fears were entertained that Mr. Preece would have but a small attendance. In spite of the heavy wind and rain, however, the large lecture hall was crowded, forty or fifty persons present being unable to obtain seats. Many of the aristocracy of the town and neighbourhood were present. Mr. Preece had brought a magnificent apparatus, and three or four assistants, sparing neither trouble nor expense to render his lecture what it really was—the gem of the session. Electrical and other instruments were placed in various parts of the room; the tables in front of the lecturer were covered with the paraphernalia needful to render the subject plain to the audience. Mr. Preece, who seems to have attained without trouble the true art of lecturing, treating the matter in hand in a plain as well as amusing style, commenced his subject with an account of a conversation with a lady, who imagined that written letters were transmitted along the telegraphic wires. He showed that a perfect telegraphist must be a tolerable chemist, magnetist, engineer, and electrician, as well as possess a smattering of all the sciences ending in "ology," "osophy," and "ography." The progress of the electric telegraph had been most rapid. Twenty years ago looked upon as a chimera, its iron wires now extend over the world—Europe, Asia, Africa, and America, possessed their separate telegraphs, and ere long they will all be joined in one continuous system. Time had been conquered by the telegraph:—

> Seems it not a feat sublime!
> Intellect hath conquered time.

Indeed, owing to the difference between the latitude of places, it was quite possible to receive messages earlier than they were sent. The lecturer had received one at half-past eleven a. m., which had not been sent till twelve at noon. Thus, when it is nine in London, it is 9.55 in Berlin, and so when the birth of the young Prince of Prussia took place at ten minutes past eight a. m., the fact was announced in London at five minutes to eight a. m. When the cable to America is laid, it is calculated that the message will forestall time by five hours. In 1845 England possessed 500 miles of telegraph; in 1850, the mileage increased to 1,800; in 1855 it reached to 3,400; and now it numbers 60,000 miles. America possesses 40,000 miles of telegraph; the continent of Europe 30,000; the British dominions in India, Canada, Australia, &c., 15,000. The telegraphic mileage of British Islands and their possessions is greater than that of the rest of the world put together. The lecturer divided his subject into three

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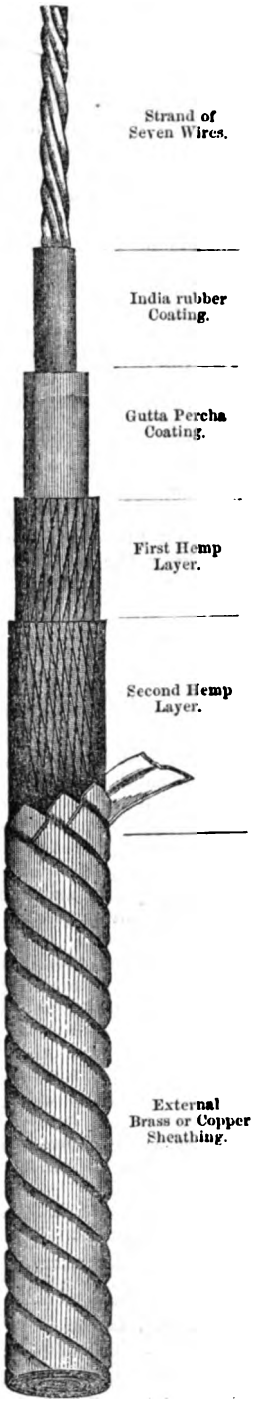
parts—the battery, the wires, and the instrument. No one, not even Faraday, could tell what was electricity; they could only speak of its powers and results. Electricity may be considered as static and dynamic. Electricity, produced by friction, so as to attract small and light substances, was well known to most people. The ordinary electric machine with its effects upon the air, its brilliant spark, snapping report, and startling shock, was then exhibited, showing to the audience some of the phenomena of static electricity. Dynamic electricity was of a very different character, operating not by violent mechanical action, but by chemical laws. It had been termed "current electricity," and was known as "galvanism," and also as "voltaic electricity." This wonderful agent might be compared to water, or gas, or steam, flowing through pipes—inasmuch as it flowed through wires which conduct and direct it wherever it is needed. Zinc and copper dipped in a vessel of water evolve electricity; if these metals are joined by a connecting wire, a battery is set in action, and a current of electricity passes through the wire. This is the fundamental principal of the science of telegraphy—two dissimilar metals—zinc, copper, and an acid solution. The power of such a battery is increased by adding others to it, so that any amount of electric force may be obtained. The effects of such batteries may be felt by taking the connecting wires into one's hands—and have, in fact, given to the battery the name of a "shocking invention." This current electricity has also the power of generating heat, and is used for blasting rocks, mines, &c. It generates light, decomposes chemical substances, and also produces magnetism—a property most extensively used in telegraphing. A large magnet was then experimonted on, and various startling effects were produced. The wires were the next part of the subject—not, however, fully understood, as evidenced in the conversation between two niggers:—

Jumbo.—"I say, Sambo, what am dem poles for?"
Sambo.—"To hold up de wires, in course!"
Jumbo.—"Well, but what am de wires for?"
Sambo.—"Why, you silly nigger, de wires am to hold up de poles."

—These wires perform the same operations for electricity that pipes perform for gas and water. The batteries are "electricity works," and the wires are "electricity pipes," and will conduct that electricity to any desired point. Great fears were entertained at first of the danger that would result from the telegraphic wires. The *Globe* at one time seriously calculated how soon all the birds in the kingdom would be destroyed by them. The wires are fixed to earthenware, glass, or porcelain supports, to prevent them from touching the wood, or falling to the ground, and they are stretched in beautiful regularity to prevent them from touching each other—the wires being the conductor—the supports are the insulators. For years past telegraphists had been waging battle against our damp atmosphere, and had at last succeeded. A wire resting on the supports now used works through all weathers from "Land's End to John o' Groat's." At one time a shower of rain prevented everything. Now, whatever may be the state of the weather, the telegraph is never stopped. Marine telegraph cables were next considered, and the great difficulty of their construction, and other arrangements, dilated on. The third part of the lecture related to the telegraphic instrument by which messages are read. Several specimens were then exhibited and put into action. The "needle instrument" and "recording instruments" were fully explained. Of the needle it could be said, "It does not speak, it does not write, but the movement of its little fingers it tells the quick-eyed watcher, hundreds of miles away, your thoughts, your wishes, and your desires." The "printing instrument" was then put into work, and excited great interest, printing off long slips of paper with the utmost despatch. The lecturer stated that instruments had been devised which print off messages in bold Roman type, and others, by means of which the actual handwriting of persons is re-produced at the corresponding end of the telegraph. Distance was practically annihilated by this invention. In the early part of last Spring a clerk in the London office, describing the fearful storm raging over London, asked his correspondent in Amsterdam the state of the weather there, "Warm, calm, and a lovely moonlight night," was the reply. He next asked Berlin:—"Blowing very hard, and rainy," was the answer. He then tried St. Petersburg:—"Bitterly cold; the ice has not broken up." He then tried Moscow, with the same result. At last he got down to Odessa, 3,500 miles away, and the answer was "Beautiful! a lovely Summer's day." Thus in two or three minutes he had worked through the seasons of the year, and through the ordeal of nearly every atmospheric phenomenon. It is, however, impossible to follow Mr. Preece through his interesting lecture, which combined some of the most startling facts of science, with the most striking and humorous descriptions. The audience was kept in the most perfect command by the lecturer, who, now with a capital story, now with a striking experiment, and again with a telling stroke of wit, secured the breathless attention of every one present. Mr. Preece's style of lecturing is peculiarly his own, and he would be a bold man, and must be, moreover, thoroughly acquainted with his subject, who could venture to imitate the lecturer on this occasion. Mr. Preece was continually interrupted by the acclamations of his audience, and loud merriment from many who were present. At the close of the lecture, communications were made with Southampton, London, Bristol, and other places, and numerous messages and answers were given. At the conclusion, the chairman, N. Adams, Esq., proposed, in highly eulogistic terms, a vote of thanks to Mr. Preece for the valuable lecture he had given. The Chairman's motion being most enthusiastically responded to, Mr. Preece, returned the compliment in a few words, and expressed his regret that the friend by whom he had been influenced to give his lecture in Lymington (Mr. Hayward) was, through indisposition, unable to be present with them that evening. Mr. Preece's lecture concludes the session, and was certainly a brilliant wind-up to the most successful programme ever known in the Institution. Many thanks are due to our Southampton friends for their valuable help—Dr. Bradshaw, Mr. Stebbing, and Mr. Preece especially. We trust the acquaintance so agreeably formed will be ripened into closer intimacy, and that the names of these gentlemen will again figure on our lists of lectures.—*Hampshire Independent.*

MESSRS. SIEMENS, HALSKE, AND CO'S. SUBMARINE CABLES.



The Insulated Wire.

The metallic conductor is first passed through an insulating and

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adhesive material, such as Chatterton's compound, and then covered with pure india rubber, according to Mr. C. W. Siemens' process, in which the application of heat is avoided.

By this process india rubber bands are laid longitudinally on the conductor, and joined in the covering machine, by bringing fresh cut edges together under great rolling pressure. Where several coats of india rubber are applied, the longitudinal seams of successive layers are made to occur at right angles to each other. The insulated wire is next covered with a thin film of compound, and then with gutta percha, to give protection to the more tender india rubber.

For a more detailed description of Mr. C. W. Siemens' machines for covering telegraph wires with india rubber, see "Minutes of Proceedings of the Institution of Mechanical Engineers at Birmingham, 8th of August, 1860."

The mode of covering just described presents several important advantages, viz.: the occurrence of faults is reduced to the least possibility; the electrical superiority due to the india rubber is obtained without dispensing with the mechanical advantages offered by the gutta percha; centricity of the coating, and absolute exemption from flaws and air-holes, is secured by this mode of putting on the india rubber, and the centricity of the conductor in its insulating medium is not risked by heat, to which cables may be accidentally exposed.

Besides, the insulating properties of such wires will decrease but very little if exposed to a temperature which would injure a gutta percha core. The specific induction of gutta percha being taken as =1, the specific induction of the combined india rubber and gutta percha insulated conductor will be only 0·6 to 0·7, or almost the same as if india rubber alone were applied.

India rubber absorbs water to a great extent, which property might give rise to defects were it not guarded against by the outward covering of gutta percha. Gutta percha has a tendency to contract upon the wire, and in case of any accidental injury, this tendency will force the yielding india rubber into the cavity formed.

The thin coats of insulating compound interposed between the copper and rubber, and between the rubber and gutta percha secure firm adhesion among these materials.

The price of the combined india rubber and gutta percha insulated wire is, bulk for bulk, somewhat higher than that of merely gutta percha covered wire, but taking the high insulation and the low inductive capacity of the former into account, it becomes, not only the safest, but also the cheapest kind of insulating covering.

The Outer Covering.

To form the core above described into a cable, it is covered with a double layer of hemp strings of the strongest description, saturated in Stockholm tar, and laid on spirally under considerable tension, the twist of the two layers running in opposite directions. It is then finally covered, while the hemp is under tension, by a flexible copper or brass sheathing, composed of bands of sheet copper, brass, or bronze, put on spirally, under the influence of great pressure, and with each succeeding turn overlapping the preceding. The covering thus formed, and which is shown in the engraving, resembles the scales of fish, affording perfect protection without wanting in pliability.

The phosphuretted copper applied for submarine purposes will not corrode in sea water, but will remain in perfect condition for many years.

The tensile strength and low specific gravity of this cable, and the impossibility of the metal sheathing uncoiling and kinking, will remove many of the difficulties and risks connected with the laying of iron covered cables of the description hitherto exclusively adopted, and also will be the means of enabling the cable to be lifted from very great depths, and after the expiration of a number of years.

The elongation of this cable is very small, being only from 0·2 to 0·3 per cent. when it is subjected to half its breaking strain.

The comparative lightness of these cables makes them applicable for many overground purposes, such as military lines, or for underground purposes.

We understand that short lengths of this cable are already laid down by Messrs. Siemens, Halske, and Co.

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.		
Fine and good	2s. to 2s. 3d.	per lb.
India Rubber.		
Fine Para	2s.	per lb.
Negro	1s. 1d.	„
Java	1s. 4d. to 1s. 5d.	„

April 9, 1862. Wm. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32 xd	———
20	Do. B 7 per cent. till 1862	all	18 to 20 xd	———
20	Do. C. „ „	all	9 to 11 xd	———
Stock	Electric Telegraph	100	98 to 101	———
5	London District Telegraph	4½	3⅞ to 3¼ dis.	———
10	Mediterranean Extension Tel.	all	4 to 5	———
20	Red Sea and India Telegraph	all	18¾ to 19¼	———
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	———
1	Do. registered	all	3/8 to 5/8	———
10	Do. „	all	4 to 6	———
2	Telegraph to India	1	par. ¼ pm.	———
5	United Kingdom Telegraph	2¾	1½ to 0½ dis.	———

THE ATLANTIC TELEGRAPHS.

[From the Times.]

Some correspondence has been published between Mr. Cyrus Field and Messrs. Glass and Elliot, the great cable makers. In reply to inquiries from Mr. Field, Glass and Elliot state that they would "not be willing to manufacture and lay a submarine telegraph cable across the Atlantic, from Ireland to Newfoundland, assuming the entire risk, as they consider that that would be too great a responsibility for any single firm to undertake; but they are so confident that those points can be connected by a good and durable cable that they are willing to contract and do the work and stake a large sum upon its successful laying and working."

They add that the cable they had to contract and lay for the French Government, connecting France with Algeria, is submerged in water of equal depths to any they would have to encounter between Newfoundland and Ireland, and they suggest that the shore ends of the Atlantic should be composed of very heavy wires, as from their experience the only accidents that have arisen to any of the cables they have laid have been caused by ships' anchors, and none of those laid out of anchorage ground have ever cost one shilling for repairs.

In a letter to the secretary of the old Atlantic company they further state, in reply to objections as to length of circuit, that they did not recommend that the cable between Malta and Alexandria should be laid in three sections, as, on the contrary, they should have preferred to work it as a single continuous line. It was laid in three lengths, in obedience to the directions given to them by Her Majesty's Government, "as it was thought that a large commercial business would arise between Tripoli and Bengazi." Of course, the old company do right in making out the best case they can in favour of long lines, but the less stress they lay upon the supposed fact of the English Government taking an expensive submarine wire to assist the "commercial business" of Bengazi—the dirtiest of Moorish towns, and only heard of for the first time the other day when the plague broke out there—the better their arguments will appear. Those interested in the progress of civilization in North Africa will, no doubt, be curious to know the number of messages that have been sent from Bengazi itself to London. But it is no use attempting to conceal the fact that, as far as the science of submarine telegraphy has yet developed itself, the greatest electrical difficulty is experienced in getting signals through very long lines of submerged wire, owing to the retardation of the current; and, no matter what Messrs. Glass and Elliot may have preferred, there is no doubt that the Government acted most wisely in adopting the opinion of their scientific advisers, and laying the line in three sections. The difficulty of working through long circuits, owing to the retarding effects of inductive electricity, increases in about the square of the length of the line when long insulated wires are laid either in the earth or under water. This is not the case with land lines carried through the air, as the natural humidity of the atmosphere and the loss of electricity over the many points of support prevent any strong manifestation of inductive influence; but a long line of wire, perfectly insulated throughout its length, becomes, in fact, a Leyden jar, and in proportion to its length, so is the difficulty of discharging it to produce distinct signals at the further end increased. Thus it is that if two lines of the same dimensions and cost as regards copper and insulation were laid, one for 500 miles and the other for 1,500, the former could be worked through for a message at nearly nine times the speed of the latter. Hence a line laid in sections must always possess immense advantages over long unbroken circuits. Science may, of course, yet discover the means of working through a cable of 2,000 or even 3,000 miles as easily as lengths of 200 or 300 miles are now worked through: but at present all experience is against the attainment of such a happy result.

The second competitor for the honour of accomplishing this great enterprise is the "North Atlantic Telegraph Company," a company formed, after the failure of the old cable, to effect telegraphic communication with America by such a route as would avoid the dangers of the long stretch of sea-way between Valentia and Newfoundland, and, above all, the difficulty of working through such an unbroken length of wire. To accomplish

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these important objects, it was decided to lay the line in four distinct sections—the first from the North of England to the Faroe Islands, and the second from the Faroe Islands to the easternmost point of Iceland. Iceland itself is to be crossed by a short length of land-line to Reikiavik, the capital. From Reikiavik the cable is again to be taken under the sea to Julianshaab, the capital of Greenland, and thence across the entrance to Davis's Strait to the southernmost point of Labrador. But, as it happens, the old company have a concession, and claim the exclusive right, for 50 years to come, of landing cables on the shores of Newfoundland and along the coast of Labrador, over which the jurisdiction of Newfoundland also extends. It is stated, however, that the upper end of Hamilton's Inlet is free from this restriction, but in any case it cannot be supposed or suffered that the old company should be so short-sighted (if the Northern route succeded) as to make their monopoly an obstruction to the carrying out of the object in which they themselves have failed, and some amicable settlement by royalty on the messages sent, or by purchase or some other plan, would, no doubt, be effected to the benefit of all concerned, or an end must be put to the concession system, which has been the bane of telegraphic companies from the first. Once, however, at Labrador, by virtue of some such arrangements, and the Northern Company's labours would be over, as it would be very easy, with a few land and short sea lines, to put their cable into connection with the most northern of the American wires. The advantages of this route, of course, are that its greatest stretch of submarine wire is only between 700 and 800 miles—not more, allowing for slack, than about one-third of the distance by the old deep sea line to Newfoundland; while, on the other hand, the sections could be easily replaced or repaired, and it is in the highest degree improbable, almost impossible in fact, that all four sections would get out of order at once, and so totally interrupt the communication. The Government were accordingly applied to, to allow a series of deep sea soundings to be taken along the proposed line, and they at once acquiesced, and Sir Leopold M'Clintock was despatched in the *Bulldog* to make the survey. The result of this showed that the greatest depth of water between the North of England and the Faroe Islands to Iceland did not exceed 600 fathoms, and was generally very much lower, averaging about 250 throughout. From Iceland to Greenland the water is much deeper, though not anywhere exceeding 1,500 fathoms; while from Greenland to Labrador the greatest depth is 2,000. Simultaneously with the despatch of the *Bulldog* the company sent a private expedition in the *Fox*, under the command of Allen Young, to examine into and report upon the capabilities of the various fiords and harbours as points of landing and departure for the cables. The report of the officers and gentlemen composing this last expedition was eminently satisfactory as to the practicability of the route.

Telegraphic News.

THE RED SEA TELEGRAPH.

The latest accounts from the expedition for the repair of this communication state that Mr. Latimer Clark, C. E., had returned to Suez, having completed the work at Jubal. In addition to completing the engineering detail, Mr. Clark has made an arrangement on behalf of the Telegraph to India Company, with the Egyptian Government, of a very beneficial character, under which the latter give up in favour of the English company the receipts of the land line between Suez and Alexandria, amounting even at present to some £2,000 per annum.

The cable is said to come up very nicely from moderate depths, although the exterior wires are in many places rusted asunder, leaving only the gutta percha core, which is as good as ever.

The most interesting thing that has yet been found during the expedition is that in several instances evidences of the action of heat (possibly from volcanic bottom or boiling springs) have become apparent to an extent that could scarcely have been credited. These have been merely local cases, but they are abundantly sufficient to account for the destruction of the communication.

It is not known whether this is confined to the Jubal portion only, or whether it is general. If it is, the only wonder will be how a signal was ever got through at all; but at the same time it points to the certainty of future success, for such mistakes can hardly be permitted to occur twice.

THE CAPE OF GOOD HOPE TELEGRAPH COMPANY (LIMITED).

The prospectus of this company has just been issued. The undertaking commends itself to the active support of all interested in the progress of our valuable dependencies in South Africa. The capital is £62,000, in £5 shares, and the success of the enterprise is already secured by, among other advantages actual and prospective, a subsidy of £1,500 per annum for fifteen years, granted by the colonial Legislature, while the contractor pays interest at the rate of 6 per cent. per annum on the amount paid up during the construction of the works. Mr. C. J. Wollaston is the engineer and general manager, and the direction is of the highest character. Mr. G. S. Seymour is the broker. We anticipate that this undertaking will prove highly remunerative to the shareholders.

The following letters have appeared in the *Times*:—

SUBMARINE TELEGRAPHS.

To the Editor of The Times.

Sir,—Towards the close of your report of the proceedings in the House of Commons on Monday night is recorded a short conversation on the subject of the Red Sea Telegraph, in the course of which Lord Fermoy is made to say that he "hoped, as gutta percha had failed as an insulating medium, the Government would guard against its use by the new company."

Sir J. D. Hay is also represented as saying, "that the preparation of gutta percha had been as yet very unsuccessful, and that the only perfect insulation was that procured by india rubber. As Her Majesty had appointed a Commission to consider the subject, he trusted that the Government would not deem the matter unworthy of their attention."

I hope that it may prove that the noble lord and the hon. member for Wakefield were misunderstood; but as a member of the Commission alluded to, and having no interest either in gutta percha or india rubber, beyond a desire to assist in the selection of the best insulating material for the still greater undertaking of a cable across the Atlantic, I think it desirable that the Government and the public should be cautioned against receiving as authentic these very inaccurate statements.

The fact is, that the elaborate experiments made under the authority of the Board of Trade showed that, except under very exceptional circumstances, gutta percha was the best insulator, as it was also proved to be impermeable to sea or fresh water under a pressure of 20,000 lb. to a square inch—equal to a column of water about nine miles in depth.

So far from gutta percha having failed in submarine lines, I need only refer to the fact that in nearly all the sea-going and oceanic lines now submerged and in efficient working that substance alone is used; and at the late *soirée* at Mr. S. Gurney's house, held to illustrate this subject by corresponding with the most distant parts of Europe, as well as with the coast of Africa, the correspondence was conducted with uniform success and marvellous results, through wires insulated by gutta percha alone.—I am, sir, yours faithfully, J. Stuart Wortley.

To the Editor of The Times.

Sir,—At page 10, paragraph 4, of the Report of the Submarine Telegraph Committee it is said that "the Red Sea telegraph failed owing to the gutta percha having been softened by heat."

After various other incidental notices of the defects of gutta percha as an insulator, at page 15, paragraph 2, it is shown "that the admixture of sulphur, which is used with gutta percha to make it tenacious and leathery, causes it to be so combustible as to lead to its destruction from taking fire."

At page 22, clause 6a, it is said "that india rubber surpasses all other materials in the smallness of the amount of inductive discharge and the perfectness of its insulation."

At page 24, paragraph 2, it is said "when gutta percha is the insulating subtance, the faults arise most frequently from airholes produced during the preparation of the material;" and then, lower down, "in wires covered with masticated india rubber these particular defects do not occur to such an extent."

At page 25 it is further said, "that no material, however promising, can be relied on until it has stood the test of time."

At page 33, section 2, it is said, "of the materials which have been submitted to us the best insulator by far is india rubber."

At page 34, paragraph 2, "india rubber and Wray's compound are not perceptibly affected by any ordinary increase of temperature, but increase of temperature has a very decided influence in diminishing the insulation of gutta percha."

This report is signed in April, 1861, and I merely call attention to the above extracts, which might easily be multiplied, in support of the remark I made in the House of Commons, which was criticized in your impression to-day by Mr. Stuart Wortley.—I am, sir, your obedient servant,

J. C. D. Hay.

44, *St. James's Place, S.W.*,
Thursday, April 3.

The Bright Testimonial Committee have published a statement by which it appears that the subscriptions amounted to £148 12s. 7d., and the number of subscribers whose names are on the list is over 260.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

FAULTS.

To the Editor of The Electrician.

Sir,—We are at liberty to suppose "Inspector's" "German" forgot to take the skin off his dead "elephant" (of course he was not "closeted" with a live one); or, by "reasoning the matter" *à la* Owen, scalpel in

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hand, "tobacco" and its "fumes" notwithstanding, he would certainly have penetrated deeper into its "structures" than "the Englishman who journeyed to Africa and saw the animal" with its skin on—a tissue, not proverbial for transparency even to English eyes.

But, to be serious, "Inspector," on his part *seemed* to be disparaging theory; I, on mine, evinced anxiety lest electricians, while careful to describe accurately the bones and sinews of their unwieldly subject should be careless about knowing how its parts were put together; he disavows writing with such an intention, and will therefore pardon my solicitude.

I cordially admit that sound electrical theory can result only from experiment, but it need not result even from that; we are now having *no end* of experience, but where is the beginning of sound theory? We are palpably in want of a process of causation by which we can reason the facts together into a thing, we must have the physiology of our electrical elephant as well as its anatomy. If argumentative minds will deliberately study the facts collected by observation, and observers will listen inquiringly to arguments for their explanation, all will be helping towards the attainment of the great universal desideratum. And when that is found none will need to shrink from "preferring theory to practice," for it will be seen to be the prolific progenitor of practice as well as its offspring.

"An Old Hand" delights me with his common-sense view of the matter; in order to win over the careless about theory to a perception of its usefulness, he advocates the production of cases in which it can be simply and clearly applied: the practice must be a good one, although we are too apt to rest satisfied with knowing the circumstances of a fact, forgetful of its having a deeper and still hidden causation. "Superintendent" is evidently disposed to do what he can to promote the practice, and I should rejoice to see a multitude of others following so good an example.

"Philo," in his notice of my letter, has merely expressed what I omitted to say; I subscribe to the whole of his remarks without comment.

April 4th, 1862. Au Revoir.

THE POROSITY OF GUTTA PERCHA.

To the Editor of The Electrician.

Sir,—I fear that a continuance of the discussion originated by "Momus" will result in very little benefit to the profession at large. Scientific questions are not to be decided by special pleading or smart writing. Mistrust of the evidence of our own senses is one of the earliest principles of inductive philosophy. A philosopher commences by doubting and ends by proving. If the casual glimpse of a piece of gutta percha conceived the idea that the material was porous, it should have been carefully tested, examined, and proved to be so. I have for twelve years handled gutta percha, and india rubber too, in every variety of form and shape. My eyes do not inform me that gutta percha is porous. On the contrary, a more solid impermeable looking material can scarcely be discovered. I have before me at the present moment a piece of sheet percha, rolled very thin, for jointing purposes. It is transparent. I hold it up to the light—not a pore is visible. It is smooth, clean, tough, and compact. If I were to believe the evidence of my eyes I should say that it was not porous. Can a more solid looking substance than gold be conceived? Yet we know gold to be porous. Can a more porous material than leather be produced? Yet leather can be made impermeable. Iron appears to the eye as good a conductor as copper, but we know it is not so. Aluminium appears as heavy as silver, but we know it to be considerably lighter. How then can we trust to our own unaided vision to solve an abstruse fact.

I, in common with the majority of your readers, will abide by the results of the careful and elaborate experiments of Professor Miller and Mr. Fairbairn—than whom, two more impartial, talented, and unprejudiced enquirers could not be found. Gutta percha and india rubber are unquestionably porous, but gutta percha is considerably less porous than india rubber. Experiment verifies it; experience confirms it; and no amount of argument or false reasoning can disapprove it. There is no denying the stern logic of facts.

Let "Momus" digest the following:—

"We have the best means of knowing that gutta percha, as an insulator, can now be manufactured almost to perfection. . . . . Since the publication of the Commissioners' Report on Submarine cables, we have taken some trouble to investigate the gutta percha question, and we cannot find that the failure of a single cable is traceable to the inefficiency of that material."—*Mechanic's Magazine, April* 4.

"India rubber is advocated by some as the best insulator, but gutta percha is found to combine the advantage of durability with pliability, is easily repaired, and has never been known in any case to decay under water."—*Ibid.*

Mr. Varley, at Mr. Gurney's soiree, said "gutta percha was the substance hitherto successfully used for insulating the conducting wire from the ocean. . . . . The Gutta Percha Company have succeeded in almost destroying its porous quality. . . . . Insulation improved with pressure. The pressure rendered the gutta percha less porous, and consequently instead of injuring the cable tended to insure its safety."

Are these statement compatible with "Momus'" conception of the relative porosity of gutta percha and india rubber?

Locke, that grand philosopher, says "One should not dispute with a man who through stupidity or shamelessness denies plain and visible truths." If I disappear from this discussion your readers will divine the reason. P. Q.

P.S.—May not your correspondent mistake some other material for gutta percha?

VOLTAIC BATTERIES.

To the Editor of The Electrician.

Sir,—You will much oblige me by giving me an answer to the following questions.

Is there any difference in the *quality* of the electricity proceeding from different sources, or only in the quantity? We find it generally stated that a Grove's or Bunsen's battery has more intensity than a Daniell's, a Daniell's than a Wollaston's, and so on.

Now what does this mean? Does it only signify that one produces a larger quantity of electricity than the other? If no more than this is meant, a Daniell's larger in a certain degree, or a Wollaston in another degree ought to act precisely like a Grove or Bunsen of a certain size, and if it be so, where is the advantage of the latter with their noxious gases? Is this so, or is there any difference in the intensity or other quality of the two,and. if so, what?—Your obedient servant,

A Learner.

[Different sources may vary, not only in the quantity of electricity set in motion, but also in the intensity or tension which gives to it the power of overcoming resistance. Taking equal surfaces, a greater quantity of electricity is supplied, at a somewhat higher tension, in the case of the Grove or Bunsen battery than with the Daniell arrangement. The latter is, however, generally to be preferred, as the quantity and tension of the electricity supplied may readily be increased, and it is free from the objections you refer to. The subject has been fully treated in "The Student."—Ed. E.]

To the Editor of The Electrician.

Sir,—Referring to pages 227, 239, and 261, on the subject of "Tunnel Telegraphy," I was in hopes of seeing so important a matter discussed with zeal by good, persevering, and practical hands, and the matter put in such a form that the travelling public would say of the Electrician "Well done!"

But I cannot see that any of your correspondents have, up to this time, thought the matter over for themselves. They each seem to have a pet system to advocate, or, like rusty vanes on church spires, point in the direction they have long been accustomed to.

I shall doubtless shock "Inquisitive" when I say that I have not the slightest faith in any system of tunnel telegraphy invented, or ever to be invented.

I have never been convinced yet that it is necessary for a train to be escorted by telegraph through a tunnel, while it is left to Providence to guide it over viaducts, curved cuttings, and tubular bridges. What does a traveller or engineman care whether he be in a tunnel, a cutting, a tube, or a viaduct at 12 midnight? nothing; tunnels, cuttings, tubes, and viaducts are all the same to them, they look the same, darkness everywhere.

From the reasoning generally put forth after tunnel accidents, it would almost seem that tunnels were made on purpose for accidents to occur in, and that "pitches in" could occur nowhere else. It is all moonshine. There are scores of tunnels without telegraphs, that no accident has ever occurred in, and dozens of tunnels that never knew any accident not caused by the telegraph. That at Clayton Tunnel would never have been had the tunnel been unguarded. The gentleman quoted by Mr. Newman, Mr. Edwin Clark, understood this, he had mastered the matter, and *suggested* a plan, *suggested*, I like that word better than *patented*. A plan that was simple in the hands of simple people, and efficient on the railway of railways. But this was not a plan to guard a tunnel, but one by which every inch of the line should be protected. And the public should decide that a system like this, that keeps all trains a given distance apart is *the system*, and that one made for tunnels only is no system at all.

Crumlin.

To the Editor of The Electrician.

Sir,—Mention was made the other week about the gold-leaf electrometer; I beg to say that I have some time ago substituted very fine tissue-paper for the gold-leaf, and this appeared quite as sensitive with this advantage, that it is cheaper, easier made, and not so frail.—I am, sir, yours respectfully, D. Sunks.

Accrington, April 8, 1862.

To Correspondents.

L. L. S. states, in answer to inquiry last week:—The armature of the electro-magnet is about ⅛ of an inch from the magnet. The retaining spring is a very light watch spring, just sufficient to sustain the armature. The electro-magnet is coiled with 27 yards, No. 22 wire. See letter in No. 21, signed, "L. L. S."

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The Electrician.

Vol. I. No. 24.—April 18, 1862.

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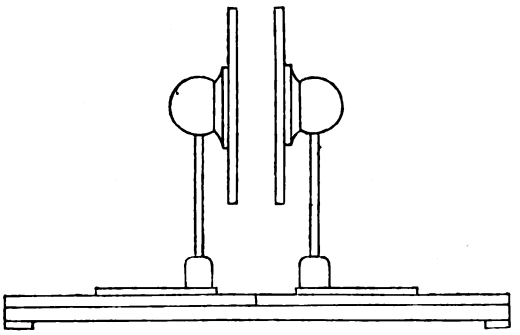
STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 267.]

158. In our former pages it was demonstrated on the principles of our theory, that the quantity of electricity dismissed from its natural combination with the common matter of an uninsulated conductor, by the induction of a given plus charge acting upon it from a neighbouring insulated conductor, varies in the simple inverse ratio of the distances intervening between them. That deduction from theory we will now verify by comparing it with the results of experiment; and for that purpose we shall require an instrument called an electrical condenser, for which we are indebted to the ingenuity and particular electrical views of Professor Volta.

Fig. 26.



159. The instrument which we represent by the preceding figure is most readily constructed in the following manner; obtain two perfectly flat discs of the thinnest plate glass, about ten inches in diameter, made smooth on their edges by grinding, and each with a hole in the centre, into which is to be received the short neck of a large wooden ball, lying with a broad shoulder against the glass, to which it is to be securely fixed by means of cement, care being taken that the wood does not project beyond the glass on the other side. The ball is to be deeply perforated to receive a stout cane of varnished glass, by which the disc may be supported in a vertical position, the cane being fixed below into a socket rising from near one of the sides of a flat square wooden foot with bevelled edges. The lowest part of the disc should stand at least three inches above the socket of the glass support; and the two feet fitted to slide in a wide space inclosed between two long bevelled guide-pieces that keep them firmly down upon a square stand, while admitting of their sliding freely backwards and forwards, without any shake, and so that the faces of the discs may be placed parallel to each other, and either in mutual contact, or at any desired distance apart up to about six inches. One of the guide pieces may be divided into two lengths, and each of its halves fixed to the stand by adjusting screws. And, lastly, all the exposed parts of the discs and of the balls cemented to them should be smoothly covered with tinfoil.

160. For several purposes for which this Volta's condenser will be useful, it is essentially necessary that it be so free from faults in construction, that the metallic faces of the discs may be advanced to within a very minute distance of one another without risk of coming into accidental contact by reason of vibration; and the proper perfection will not be secured unless the glass supports are very strong in proportion to the weights they have to carry, and well secured by unyielding cement joints, so as to remain accurately parallel to one another, and in exact vertical positions; the sliding feet should have wide-spreading bearings well rubbed with plumbago.

161. With an instrument thus constructed, added to parts of our other apparatus, we can experimentally ascertain whether a charged conductor, acting by induction upon another that is uninsulated, causes it to dismiss into the earth portions of its own natural electricity, varying in quantity in an inverse simple ratio of the distances between them; which we shall know to be the case if we find experimentally that the intensities of the electrical force of the quantities so dismissed, and acting as plus charges, vary, as by the theory they should do, as the inverse squares of the distances. Or, what amounts to the same thing, if we find the intensities of the negative charges left by those dismissals to vary in that inverse ratio, because the quantities of negative charge thus left are simply proportionate to the electricity dismissed.

Exp. 25. Set the discs of the Volta's condenser *a quarter of an inch* apart, and by wires of communication connect one of them with the under disc of the Balance Electrometer, adjusted to a distance of half an inch from its fellow, and the other with the ball of the coated jar. The other arrangements being as before described for Experiments 12, 13, 14 (par. 41), and with the discharging electrometer intervening between the jar and the positive conductor of the electrical machine.

Count a given number of electrical sparks into the jar, part of each of which, proportionate to the relative charging capacity of the disc of the condenser with which the jar communicates, will place itself upon that disc. Uninsulate for a moment the opposite disc of the condenser by touching its ball with the finger, thus allowing whatever portion of its natural electricity may have been liberated from it by induction to pass away into the earth, and leave it with an induced minus charge. Then, after re-establishing the insulation, draw quite away the plus disc of the condenser, and discharge it together with whatever is in connection with it, so as to leave the minus charge of its fellow free to distribute itself over the conducting surfaces communicating with it; under these circumstances the under disc of the Balance Electrometer will become minus, and act by induction upon the disc suspended over it with an intensity of attraction determined by the minus charge, that is to say, by the quantity of electricity which has passed into the earth during the temporary uninsulation of one of the discs of the condenser while under the induction of the other. Using the hydrostatic arrangement of the Balance Electrometer, as already explained (Exp. 12), note the intensity of attraction, and consider it to result from an unit of distance.

Exp. 26. Then after discharging all the conducting surfaces, place the two discs of the condenser *half an inch* apart, that is, at double their former distance, and repeat the experiment, counting through the discharging electrometer the same number of electrical sparks as before; note the resulting intensity as that due to the quantity of electricity dismissed by induction at two units of distance.

Exp. 27. Discharge the conductors again, and repeat the experiment a third time with the two discs of the condenser set to a distance of *three quarters of an inch* apart, and note the intensity that will have been observed as that due to the quantity of electricity dismissed by the induction at three units of distance.

162. Now, upon comparing the intensities thus obtained we shall find, if the experiments have been carefully performed, that they vary in a ratio corresponding to the series 1, ½, 1-9th, or,

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to take whole numbers, as 36, 9, and 4, that is to say as the squares of the distances inversely; for 36 (taken as the unit of intensity) ÷ 1 = 36, for an unit of distance; 36 ÷ 4 = 9, for two units of distance; and 36 ÷ 9 = 4, for three units of distance. Thus, while the intensities have been as 36, 9, and 4, the quantities have been as 6, 3. and 2, and those numbers are to one another as 1, ½, ⅓ (par. 161).

163. It has been mis-stated in an educational work for students in electricity, that, under the circumstances in which we have been employing the condenser, the electricity which leaves one disc under the inductive influence of the other is "similar in quantity" to the inductive charge itself. The work in question is too generally read for any mis-statement in it of facts to be otherwise than mischievous if passed by without comment; but the only remark we need make about that to which we are now called upon to refer, is to say that it is, by implication, corrected in the page immediately succeeding, where we find it said that under the induction of a given charge in one of the discs the quantity leaving its fellow is not constant at all distances. Now if it were always equal to the inductive charge it could not vary with distance, so that the student will at once perceive that both statements cannot be true. Theory points out which of the two is to have our confidence, and that confidence we may easily confirm by practical observation, for if we charge either of the discs while the opposite one is temporarily uninsulated, and then, after insulating it, put it into conducting communication with its fellow, we shall find that the plus and minus charges will not neutralize each other, as they obviously should do if, as asserted, they had been "similar in quantity;" but there will be an excess of that which was inductric remaining on the discs, and only requiring an application of the electrometer for its detection. That excess, our doctrines inform us—and experiment would prove the information to be true—will be greater as the distances are so at which the uninsulated disc is placed when it participates in sustaining the induction.

164. Presuming to attempt—for we must acknowledge we are making such an attempt—to correct generally such imperfections in electrical doctrine as obstruct the dissemination of what we believe to be truth, and for the detection of which we imagine we have been in some measure accidently qualified by stumbling upon a leading conception that has carried us forward, one step after another, in a manner quite unprecedented; we have next in turn to speak of another view of static electrical induction which comprises much that is true, though it falls short in its fundamental conception of causation, as we must believe from the circumstance of its accumulating around it difficulties which it abandons as unmanageable. While we thus declare the shortcoming of a doctrine taught by no less a genius than Faraday, whose practical doings will for ever—until electricity cease to be cared for—secure for his name the homage of admiration and respect; it is with the greatest satisfaction we say of it also, that to it were we first indebted for that important conception—*the propagation of induction by contiguous particles*—which we are now tracing in the causation of whole classes of measurable electrical phenomena. In addition to that happy idea, its author wanted in theory to arrive only at a limitation of the electrical attraction—and in his doings and sayings about *electrical equivalents* he almost trod upon the heels even of that discovery—and then his doctrines respecting static electrical induction would have assumed an importance very far beyond that attained, and have illumined the science with a ray of light that must soon have burst into meridian splendour, certainly saving us the task upon which we are now engaged. Had *Electra* but whispered in the ear of her favoured disciple the magic words *limited electrical attraction*, and the practical gems in his "Researches" would have found a theoretical setting worthy of their brilliancy, and which now they have not.

165. With what we have at present further to say we need not be long occupied, as we intend to pursue the same subject in our next. Faraday, by raising up upon his practical observations a reasoning that was at once laborious, minute, and sagacious—though not sufficiently independent of scholastic dogmas—knew that electrical action in one particle of matter set it up in other particles next to it in local position, that those set it up in others beyond, and thus onwards, inducing an electrical action throughout a long line of particles, which it further appeared might be other than a right line; but he stopped without learning the *nature* of the induction, and with it the *law* that regulated its intensity, imposing upon its sensible action a very prompt limit. Eminently a practical man, his doctrines seldom extended themselves beyond the narrative and immediate relation of his facts—where they did not at once lead him he seldom penetrated.

(To be continued.)

INDUCTIVE CAPACITY OF INSULATORS.

The nature and effects of static induction appear to be very imperfectly understood by a large proportion of those who are more or less familiar with the expression as latterly employed in the practical bearings of electrical science. The term "absorption," which has been used to designate the amount of electrical charge held under induction in an insulated conductor, of which the covering is in free contact with the earth, appears in many cases to have led to the impression that "induction" is merely a species of "conduction" manifested in insulating bodies. This impression may probably have been strengthened by the very questionable assertion, contained in the Government Report, that, "generally speaking, the more perfect the insulating property of a material, the less is its inductive capacity," which is true only in regard to a few insulating materials in practical use. The mistake to which we refer may be amusing to those who have entered into the theory of electrical science as well as into its applications; but it may be considered that some of these gentlemen are in great measure answerable for the obscurity in which the question of the inductive capacity of insulating materials has been involved. The terms "discharge," "inductive capacity," "specific induction," "retardation," and "absorption," have been used in such a manner as to lead almost inevitably to confusion in reference to this question. Of course the meaning of the writers may generally be clear to those who understand that the "discharge" from a covered wire is the measure of the inductive capacity of its surrounding dielectric, and that the "specific induction" of the insulator on a thickly coated wire giving little "discharge," or occasioning little "retardation of the current," may yet be greater than that of the insulating material of a thinly coated wire allowing of considerable "absorption;" but to the uninitiated, the multiplicity of terms, where one might well be adhered to in indicating the character of the covering, is more than likely to occasion misconception.

Let us endeavour to make the matter clear to those who may have but little time or opportunity for abstract studies. We will take one of the moveable coatings of a Leyden jar, and place it upon a glass tumbler or a "pole insulator." It may now represent an overland wire suspended in air. If we establish a connection between it and the prime conductor of an electrical machine, or if we touch it with one of the terminal wires of a battery of a thousand couples, it will receive an electrical charge, and may be discharged, with the production of a spark, by touching it with a conductor in free communication with the earth. The charge thus given, however, is very small in comparison to that which may be communicated, under different conditions from the same source. Supposing the metallic coating to be that of the inside of the jar, let us place it in its original position. The conductor is now surrounded with an insulating material, in this case glass; and it may represent an insulated submarine wire. Wires of this kind are generally covered externally with a metallic casing, which is analogous to the outer coating of the Leyden jar. But whether this exterior metallic covering be adopted, or whether we

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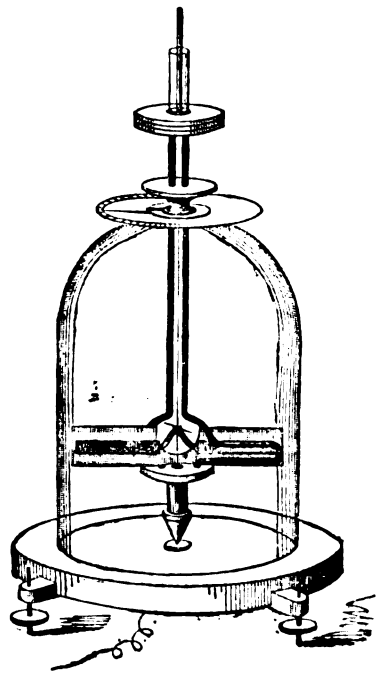
surround the glass with any other conducting body in free communication with the earth, the same effect will be produced. The insulated inner coating will receive from the same source a charge of comparatively enormous amount, as may be tested by discharging the conductor through the body.

If now we substitute a thinner glass jar with coatings to match, for that we have used, we will be able to obtain a still higher amount of charge, and consequently of "discharge." The "inductive capacity" of the thin jar is greater than that of the thicker jar. Let us see what this means. Every electrical charge is retained by insulation, and thus the bodies which are termed *electrics*, and which furnish electricity by friction, are also non-conductors, and their electricity is moreover retained by the non-conducting atmosphere. All non-conductors or insulators become "polarized" under electrical influences, *i. e.*, have the capacity of inducing an opposite electrical change in conducting bodies surrounding a charged conductor. As therefore every electrical charge is retained by insulation, it necessarily exists also under induction. The inductive capacity of any given insulator, or the resistance it offers to polarization, is inversely proportionate in a certain ratio to its thickness. In the case of the overland wire, the air between it and the soil is the principal insulator through which the electrical charge is retained in the conductor, and, by reason of the great volume of the same between the wire and the soil, the capacity for induction of this insulator is very small. In the submarine wire, the thickness of the insulator between it and the surrounding conducting substance is very small, and the inductive capacity of the insulator is greater.

Instead of the thinner glass jar, let us take a similar vessel made of sulphur, of equal thickness with the first jar. The "specific inductive capacity" of sulphur is much higher than that of glass; it is a better "dielectric," probably because its particles are more easily polarized under electrical influences. Insulated with sulphur, therefore, the inner coating of our Leyden arrangement will take a much higher charge than in the case of the glass jar of equal thickness. Supposing, however, the second glass jar to be very thin, the amount of charge it would allow the inner coating to acquire may be greater than that of the sulphur arrangement. In this case the inductive capacity of the glass jar would be greater than that of the sulphur jar; although the *specific* inductive capacity of sulphur is higher than that of glass.

If, instead of the sulphur jar, we take one of equal size and thickness, constructed of gutta percha, the charge of our Leyden arrangement will be much less than in the case of the glass jar. With india rubber, the charge will be little more than half that obtained with the gutta percha dielectric; always supposing the vessels to be equal in size and thickness.

An insulated telegraph wire laid in earth or water is in point of fact a Leyden arrangement, the inner coating of which becomes charged by the battery. The same may be said of the wire suspended in air; but in this case, as we have pointed out, the static charge of the wire is very insignificant by reason of the great resistance opposed to induction by the surrounding atmosphere. The practical inconvenience which results from our having to communicate to a conducting wire a considerable static charge before the current of the further end becomes sufficient to record a signal, and still more from our having to wait after each signal until the wire has become discharged, is so well known that it need not be stated that it is a matter of great importance to oppose as much resistance to induction as possible in the construction of submarine cables. The less the inductive capacity of the insulating dielectric, the less will be the charge communicated to the wire, and the degree of "retardation" of the current. The thickness which is necessary in the insulating envelope is not, beyond a certain extent, determined by any reference to the degree of insulation required, but by the amount of inductive resistance which may allow of a rapid succession of signals along the line.



THE CONDENSING SINE ELECTROMETER.

The above woodcut represents a new form of electrometer, contrived by Mr. D. G. Fitzgerald, for the purpose of measuring electrical charges communicated by the voltaic battery, or from other sources where the supply of electricity is practically unlimited. The instrument is shown surmounted with the condenser of Peclet, by means of which the amount of charge may be increased. To the lower plate of the condenser are attached the two pieces of stout brass wire, which form the stem and arms of the instrument. The wires then pass through an ebonite button, with a rough edge, by means of which the stem may be made to revolve upon its vertical axis. The lower portion of the button carries an indicating needle, which, when the instrument is adjusted, points to zero upon a graduated scale, giving the quadrant of a circle. The scale is supported upon a perforated disc of ebonite attached to the glass shade. The brass wires, after having been bent to form the arms of the instrument, are attached to a piece of ebonite, forming a reservoir to hold a few drops of mercury, which are in contact with a piece of metal forming the pivot on which the stem rotates. The pivot-plate beneath the latter is placed in contact with the earth by means of the wire shown in the figure.

A strip of thin glass, or of cartridge paper saturated with white wax and varnished several times with shellac, is passed between the two arms of the instrument, and attached to one side of each respectively. The needle is made as light as possible of metal foil, and is suspended by a fibre of baked silk, so as to be in contact with the dielectric attached to the opposite sides of the two brass arms. This needle carries a small magnet, and by means of a fine wire attached beneath its centre of its suspension is brought into metallic communication with the mercury in the reservoir, and consequently with the earth. It will be seen that it is analogous to the outer coating of a Leyden jar, and that when the brass stem of the instrument is charged from a source, it will assume by induction an opposite electrical charge, and be attracted to, and retained in contact with, the dielectric.

The force of terrestrial magnetism—exerted in a horizontal direction, in virtue of which a magnetic needle tends to return to the magnetic meridian, when it has been deflected from this direction, varies as the sine of the angle of deflection of this needle. On the basis of this fact, the sine galvanometer, an instrument offering accurate comparative indications, has been constructed. By attaching a magnetic needle to the indicating needle of the condensing electrometer it is obvious that the principle of the sine galvanometer may be applied to the electrometer, the needle of which is attracted to the surface of the coating of dielectric upon the horizontal arms of the instrument. The brass arms being brought parallel with the indicating needle when its attached magnet is in the magnetic meridian; the instrument may then be charged, and made gradually to revolve upon its vertical axis until the force of terrestrial magnetism becomes greater than the attractive force of the needle to the arms of the

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instrument. The needle will then suddenly return to its original direction; and the degree to which it has been deviated, measured upon the scale, will afford an accurate electrometric indication; the sine of the angle being taken, and the comparative quantities of electricity in action equal to the tensions at the electrical sources, being calculated at the square roots of their attractive forces.

We give the description of the instrument without any further comment, as the principles on which its construction is based may form an interesting subject of study, and perhaps of discussion, to some of our readers who have given their attention to the question of electrical measurements. It should be stated that the construction of the Condensing Sine Electrometer may doubtless be improved upon, so as to render it more free from accidental sources of error. This is the opinion of Mr. Becker, who deserves, *par excellence*, the appellation of *l'artiste aux mains de fée*, bestowed by Gavarret upon M. Froment, the celebrated philosophical instrument maker amongst our French neighbours. We will reserve our opinion of the practical merits of the instrument until we have tested one of Mr. Becker's construction.

OXIDISED OIL.

The following is extracted from the valuable paper of Mr. F. Walton, read before the Society of Arts, on the 2nd inst., "On the Introduction and use of Elastic Gums and Analogous Substances":—

Having reviewed the introduction and uses of india rubber and gutta-percha, it remains for me to present to your notice the new substance and its treatment, referred to at the commencement of this paper as its leading feature; and I believe, making due allowance for the usual sanguine temperament of inventors, I shall be enabled to place before you such particulars in relation to my discovery as will convince you of its value, scientifically and commercially, and that you have not conferred so much kind and patient attention on an unworthy object.

Numberless attempts have been made to produce a material possessing the qualities of india rubber, and this material, together with gutta percha, has been distorted into all forms, and has been compounded, in a most heterogenous manner, by a host of experimentalists seeking to produce a cheaper material, but no available results have been arrived at. The cheapest base for experiment had, I humbly submit, been neglected. It is well known that linseed nut and poppy oils possess that nature, which distinguishes them from lubricating oils, of becoming concrete on exposure to the atmosphere; that is, that when spread in a thin layer on a surface of wood or iron, they dry or change into a thin skin. This change, which is erroneously called drying, is produced by the absorption of oxygen and the disengagement of carbonic acid, and is, in reality, only a change of their elementary constitution.

This property of absorbing oxygen rapidly is not considerable in the crude or raw linseed oil, but it is very greatly increased by boiling the oil, that is, exposing a large quantity of raw oil to a strong heat in a cauldron, with a small per-centage of metallic oxide of lead added. It is then called "varnish," and has a more viscid character, and it is also rather more highly coloured. A layer of this oil requires from 6 to 24 hours to dry or change into a skin-like substance, according as the state of the atmosphere is more or less favourable.

I cannot do better than give to you a detailed account of the circumstances which combined to bring this subject before my notice. Whilst engaged, about two years ago, in a series of experiments on the manufacture of artificial leather, it was of the greatest importance to the success of the material that it should have a coat of fine varnish, which, whilst drying quickly, possessed the flexibility of india rubber. Copal varnish has always been accounted the best varnish, but made with drying oil combined with gum copal at a high temperature, it will not of course, be dry until the action of oxidation has reduced the oil contained therein into a solid film. Whilst revolving in my mind this knotty difficulty, and presenting every phase of it to careful thought, it suddenly occurred to me that if the oil was first dried into a skin, like those I had often seen on paint cans, but, like other people, had before considered as waste, was dissolved in a volatile solvent, like india rubber sheet; that the semi-resinous material would immediately on the evaporation of the solvent, resume, like india rubber, the form it was in prior to solution. By dipping panes of glass into linseed oil, and allowing the films or layers to dry, then repeating the process, I imitated the manufacture of india rubber from the milk, and thereby produced a solid elastic substance, composed of many layers of perfectly oxidised oil. Up to this stage I had done nothing new or original, for the oil-sheet manufacturers have for more than a century waterproofed linen by layers of oil. But to treat this semi-resinous matter and render it available to purposes of manufacture, will be admitted to be perfectly new, and I now proceed to describe the invention. Having accumulated a quantity of solid oxidized oil by drying it upon extensive surfaces of any kind, such as prepared cloth, stretched in frames, as described in my patent of the 27th January, 1860, I then scraped or peeled it off by suitable means.

At first, as before stated, my attention was solely directed to the attainment of a speedily-drying, flexible varnish at a moderate temperature, but very few experiments with this oxidised oil led me to notice its rubber-like qualities, which I at once conceived might, with further manipulation, and with some combinations, be developed more fully, and become a very valuable substitute for that article.

Encouraged by success at every step, I proceeded, and soon found that by crushing the solid oxidised oil obtained in sheets as described in my patent, and working it thoroughly in hot mixing rolls, I produced a substance which required only the cohesive nature, which in the early part of this paper we noticed as existing so strongly in india rubber. The addition of a small proportion of shellac soon gave that which was wanting, and I found in my power a material singularly like caoutchouc when worked into dough, and which could be rolled on to fabrics in the same manner and with the same facility—giving a perfect waterproof cloth, unlike oil-cloth, but having the rubber finish and flexibility. Pigments could easily be added to give colour; the addition of resins gave other, or rather varied proportions of adhesion, useful as affording the means of uniting fabrics as by rubber. Fibre, whether flock or cork, mixed in and rolled into sheets, gave me samples of kamptulicon and other floor-cloths.

These experiments were made more than two years since, and some of my earliest samples are now on the table before you—together with many of more recent date, which I have yet to refer to; and besides them you have similar productions in rubber, which will enable you to make a comparison. Although I had thus accomplished more than my first anticipations, my primary object was yet unrealized, and I had, day by day, proofs of how entirely I was dealing with a substance of which the characteristics were entirely unknown to us. Various were the solvents tried to dissolve it. Obtained from oil it was unaffected by oil; no longer did it retain any unctuous matter, one of the greatest proofs, practically, of which is, that whilst any oil or greasy matter will destroy india rubber very speedily, yet they have no effect on this; the two may be well combined. For a long time was I baffled in every attempt to find a solvent. Any heat short of carbonising it had no effect on the material, and here was evident a great advantage over rubber for practical purposes, if other desiderata were accomplished. At length I was able to dissolve this converted oil in alcohol and wood spirit—thus did I obtain the first varnish. Sufficient success had thus attended my labours to justify, at any rate in my own, perhaps sanguine mind, my patenting the discovery in England, France, Belgium, and America, and taking and fitting up works for the production of the material. But yet much remained to be achieved; the process was slow, the solvents were expensive, and did not offer all that was to be desired in the way of varnish. It was also desirable to obtain a medium state answering to the india rubber cement or dough capable of being worked by the guage spreader which I have this evening described to you, and in which it would dry as rapidly; that is, within a few minutes of its passing the machine, this last requisition creating no small part of the difficulty. Some months more of diligent experiment led to more definite results, and at length I was enabled, by experiments which involved much time and labour, to perfect the solution in the distillates of coal, preferring the usual rubber solvent, naphtha. Thus was the material brought still further into a state so nearly resembling rubber solution, or cement, that even those most accustomed to the manufacture thereof could not distinguish one from the other, and in all respects it could be treated in the same way. Samples of the varnish, of the cement, and of the dough, I have also the pleasure to present to your notice. I would here remark that the success of this discovery is mainly due to the perseverance of my partner, Mr. Richard Beard, jun., who, with the same energy he devotes to the business department of our works, more especially under his care, has rendered me great assistance in these and later experiments.

Not only has this singular product been thus assimilated to rubber for uses on fabrics, or combined with fibre for floor cloths, but, still more strange, it is capable of being worked with pigment and vulcanised exactly as india rubber has been described to be, and forms a hard compound like vulcanite and ebonite, excepting that the sulphur is not necessary. Pieces thus hardened are also placed on the table before you.

Having now explained the means of obtaining, treating, and applying this oxidised oil—its wonderful similarity to rubber must, I think, be apparent to all. I then submit that the progress of solidification of the oil is identical with the drying and solidification of the rubber on the clay moulds I have in this paper referred to, with this difference, that with the rubber it is an evaporation of the fluid which holds the particles in suspension, in order that they may coalesce, and thus, of course, there is a loss of weight, whereas with the oil there is an increase of weight (ascertained by accurate experiments) from the absorption of oxygen. Chevreul confirms this point in his researches on oil painting.

The applications of my prepared oxidised oil are not limited to its uses as a substitute for rubber, as will be seen by the following list, but before passing on to its other applications, we will notice its advantage over rubber. 1st. The great difference in price which must ever exist from the facility with which one can be produced in the natural state over the other, for abundant as are the various trees yielding caoutchouc, the difficulty of collection, the scarcity of labour in regard to quantity obtained, must always keep up the price of natural rubber, whilst the linseed from which the oil is obtained can be so easily and cheaply cultivated.

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The import of linseed in—

Qrs.		Tons.
1858—1,017,844	equal to tons of oil about	50,900
	Of which were exported	26,000
	Leaving for home use	24,900
1859—1,270,911	equal to tons of oil about	63,600
	Of which were exported	30,000
	Leaving for home use	33,600
1860—1,330,623	equal to tons of oil about	66,500
	Of which were exported	37,000
	Leaving for home use	29,500
1861—1,160,270	equal to tons of oil about	58,000
	Of which were exported	32,000
	Leaving for home use	26,000

2nd. That being unaffected by oil or grease it is more durable than rubber in many of its applications, especially where used in various manufactures, such as cards for carding wool, printers' blankets, &c. That also for purposes where rubber is injured by temperature, this is unaffected. And last, though not least, its durability, inasmuch as it is free from those elements of decomposition which, it is admitted, are set in action by the very process that it is necessary for the rubber to undergo in course of manufacture, not to notice the numerous combinations therewith in use, in too many instances, on account of the high price of the pure material.

List of Applications.

Surface Fabrics.—Clothing, carriage aprons, cart sheets, sail covers, bath sheets, nursing aprons, sponge bags, &c.

Imitation Leathers.—Carriage lining, chair covers, boot and shoe leathers, trunk covers, saddlery, bags, reticules, &c.

Common Surface Fabrics.—Packing cloths and papers, cart sheeting, tarpaulings, brattice cloths for collieries, &c.

Double Textures.—Clothing, mail bags, hospital sheeting, card cloths, printers' blankets, water and air beds, cushions, &c.

Manufacturing Purposes.—Packing for steam, water, and gas pipes, valves, machine binding, hose-pipes, tubing for carrying beer, &c.; flax-spinners' bosses, calendering and embossing bowls, cop tubes, telegraph supports, or insulators, tank linings, ship sheathing, roof coverings, shoe soles, &c.

Hard Compounds (of any colour).—Knife and fork handles, surgical instrument handles, surgical and dental appliances, tubing for chemical vessels, picture frames, trays, mouldings, furniture ornamentation, panelling, veneers to imitate marble, ivory, ebony, and other woods, &c.

Miscellaneous.—Washable felt carpets, kamptulicon (of any colour) stair coverings, toilet mats, table covers, &c.

Flexible quick-drying varnishes. Paints for carriages. Painting or printing floor-cloth, table-cloth, &c. (will dry in a few minutes), enamels, of any colour, for enamelling papier maché, metals, &c.

We now pass to the advantages to be derived in the use of the material under consideration, for some of the purposes in the foregoing list, to which boiled oil has hitherto been applied; and first we notice the important article of leather-cloth, commonly called American leather-cloth. This is prepared by coating the fabric with oil boiled to a thick consistency, mixed with black pigment. This is spread on cotton fabrics, which is placed in a temperature of, say from 120° to 150°, for a day, to dry or oxidise the oil coating. For convenience of hanging, these are in twelve-yard lengths, and this operation has to be repeated for five or six successive days, according to the thickness of the coating required; and lastly, in the same manner, a coat of copal varnish is given, each of these requiring the same length of time to dry. Thus seven to eight days are requisite to prepare the cloth for the embossing rollers. By the use of oxidised oil, properly prepared, you have all the same qualities as are obtained by allowing the oil to oxidise on the surface of the cloth, avoiding the consumption of so much heat and time, as well as injury to the fabric itself, with the advantage of being able to spread each coat successively, the solvent evaporating as when used with rubber, while it passes through the machine, the length not being limited to twelve yards, and there remains only to apply a coat of varnish to increase the brightness of the surface. Thus in one day can be done, not only the work of seven, but a greater quantity by working increased lengths. For oil-dressed cart sheets, omnibus and other driving aprons, waterproof packing materials, and a host of other such purposes, this preparation is most suitable. And lastly, we have the important use as a varnish, either as such or to mix with pigment, as a paint. We all know the time requisite for ordinary paint to dry—this we equally well know is the time requisite to dry or rather oxidise the oil in the paint. The spirit, be it turpentine or other solvent, would quickly evaporate. The coats of paint on doors and walls are but coats of oxidised oil, charged with pigment, as perfect and pliable skin as the coating of a fabric, if too much pigment has not been used. If, then, you complete the oxidation previously, and dissolve the oxidised oil so as to render it fit for application by the spreading machine of the manufacturer, or the paint-brush of the painter, when the solvent evaporates, which it does very rapidly, you have a flexible, tough, waterproof coating, which will be dry enough for succeeding coats within half-an-hour.

In carriage painting, floor-cloth manufacture, and kindred articles, months are now consumed, which might well be saved. The patterns of felt on the table are printed with colours thus prepared, and some pieces of wood, painted at the carriage factory of Messrs. Holmes, are also here.

I am conscious how imperfectly my task has this evening been accomplished, but I have shown you how analogous a substance this material is to the elastic gums. In conclusion, I beg to thank you for the kind attention you have given me, and must apologise for the many defects and deficiencies which exist in this paper. Many of them would, I flatter myself, have been obviated but for the disastrous fire which occurred at our works the week before last, at which time I was engaged in preparing these particulars, and this has prevented my carefully reviewing the sheets before submitting their contents to you. Such a fatality will, I am sure, be an adequate excuse, and this must also be given as a reason why so poor a display of samples is placed for your inspection, our stock having been entirely destroyed. And I would add that, not being waterproofers ourselves, the samples are more roughly finished than would be the case if produced by more experienced hands.

We hope to have our works in order in about a month, and then we shall be most happy to demonstrate to any one interested, the applicability of this new material to the purposes specified.

The following Tables, furnished by Mr. W. H. Preece, will be found extremely useful for the guidance of manufacturers and telegraphists generally.

Description of Wire.				Weight of 1 mile in lbs.		
B. W. Guage.	Inches Diam.	Sectional area. Square inches.	Sheet Guage.	Galvanised Wire.	Copper Wire.	Solid Gutta Percha.
1 sq. inch	1·	1·0000			20474	2218
1 cir. inch	1·	·7854			16075	1742
0000	·454	·1618854			3315	359·1
000	·425	·1418629			2905	314·7
00	·380	·1134118			2322	251·5
0	·340	·0907922			1859	201·4
1	·300	·0706860		1340	1447	156·8
2	·284	·0633472		1095	1297	140·5
3	·259	·0526854		896	1079	116·9
4	·238	·0444882		773	910·9	98·68
5	·220	·0380134		680	778·2	84·31
6	·203	·0323655		587	662·7	71·79
7	·180	·0254470		459	522·1	86·45
8	·167	·0213825		406·4	437·7	47·42
9	·148	·0172034		330	352·2	38·15
10	·134	·0113097		251	288·7	31·29
11	·120	·0093313		192	231·6	25·07
12	·109	·0070882		163	191·0	20·69
13	·095	·0054106		130	145·1	15·78
14	·083	·0040715		97·8	130·8	12·000
15	·072	·0033183		81·3	83·35	9·029
16	·065	·0026421		60·00	67·93	7·359
17	·058	·0018857			54·09	5·859
18	·049	·0013854			38·61	4·183
19	·042	·0009621			28·36	3·073
20	·035	·0008042			19·76	2·134
21	·032	·0006157			16·47	1·784
22	·028	·0004909			12·61	1·366
23	·025	·0003801			10·05	1·089
24	·022	·0003801	·082		7·782	·8481
25	·020	·0003142	·095		6·433	·6969
26	·018	·0002525	·108		5·170	
27	·016	·0002011	·113		4·117	
28	·014	·0001589	·120		3·151	
29	·013	·0001327	·124		2·717	
30	·012	·0001131	·126		2·316	·2508
31	·010	·0000785	·133		1·607	
32	·009	·0000686	·143		1·323	
33	·008	·0000508	·145		1·032	
34	·007	·0000385	·148		·6245	
35	·005	·0000196	·158		·4012	·0435
36	·004	·0000126	·167		·2580	·0279

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Specific Gravities.

Names.	Specific Gravities.	Cubic Inches in lbs.	Lbs. in cubic inch.
Water	1000		
Mercury	13560	2·038	·4904
Platina	19500	1·417	·7053
Lead	11352	2·435	·4105
Silver	10474	2·638	·3788
Copper, cast	8788	3·146	·3178
„ sheet ...	8910	3·103	·3225
Brass, cast	7824	3·233	·3036
„ sheet	8396	3·293	·3037
Iron, cast	7264	3·806	·263
„ sheet	7700	3·592	·279
Steel, soft	7833	3·530	·2833
„	7816	3·537	·2827
Zinc, cast	7190	3·845	·260

Weight of Round Cores of Gutta Percha.

Diameter.	Weight per statute mile (1,760 yards).	Weight per nautical mile (2029½ yards.)
1/32 inch	1·7006 lbs.	1·9606 lbs.
1/16 „	6·8036 „	7·8425 „
1/8 „	27·2141 „	31·37 „
3/16 „	61·231 „	70·5817 „
1/4 „	108·856 „	125·4787 „
5/16 „	170·088 „	196·0604 „
3/8 „	244·926 „	282· „
7/16 „	333·372 „	384· „
1/2 „	436·425 „	502· „
9/16 „	551·085 „	634· „
5/8 „	680·352 „	784. „
11/16 „	823·226 „	950· „
3/4 „	980· „	1130· „
13/16 „	1150· „	1326· „
7/8 „	1333· „	1537· „
15/16 „	1530· „	1765· „
1 „	1741·70304 „	2008· „

A Cubic Inch of Gutta Percha weighs 0·35 lbs. avoirdupois.

The weight of Gutta Percha being = 1·0000
„ „ Wrought Iron about = 7.955
„ „ Steel „ = 8·114
„ „ Coppor „ = 9·2278

CHEMICAL AND PHYSICAL MODIFICATIONS OF THE ATMOSPHERE CONSEQUENT ON HABITATION.

The repeated observations of chemists have taught us to regard the identity of composition of the atmosphere as a fixed law—one to which no exception is to be found in Nature, unless it be in the neighbourhood of tropical rivers, where vast quantities of organic matter, the *débris* of a luxuriant vegetation, are rapidly passing into decomposition.* Everywhere, whether collected on the top of Mont Blanc, or on the banks of the Seine or Thames, or in the middle of the Atlantic, the two main constituents of the atmosphere are found in precisely the same proportion, and the more perfect the processes of analysis have become, the firmer has the constancy of this relation been established.† This fact has always, however, been rebelled against by the common experience of mankind; it has been almost an opprobrium to science that, in spite of the manifestly different feeling of the air on the Swiss mountain and in the middle of London, the chemist can detect no difference in composition. During the last few years several chemists have directed their attention to this apparent inconsistency between the organoleptic and physical characters of the air, with special reference to the condition of the atmosphere in towns. These researches have related mainly to the quantity of carbonic acid, and other products of combustion, and to the existence of organic matter in suspension. Among the most important are those of Dr. Dundas Thompson and Dr. Angus Smith.

The per centage of carbonic acid usually existing in the air of London was found by Dr. Roscoe,* to be 0·037 per volume, a result not differing materially from those obtained by Dumas and Boussingault in Paris. The analyses on which these are based were made by passing a known volume of air over weighed tubes containing alternately pumice-stone steeped in sulphuric acid and potash, a method which leaves nothing to be desired in respect of accuracy.† Dr. Smith's estimations of the carbonic acid of the air of Manchester, made by the same method, gives somewhat higher results. He found that on a windy day they averaged 0·045 to from 0·08 per cent., and that on a still day the per centage amounted to 0·12. When, however, we consider that although London is the greatest city in the world, Manchester is the largest manufacturing town, and that it is the centre of a manufacturing district comprehending many hundred square miles, over which an atmosphere darkened by smoke perpetually hangs, we are not surprised to find that the products of combustion exist in larger proportion than in London or Paris. Dr. Smith has calculated from the quantity of coal burnt in the neighbourhood of Manchester, that 15,000 tons of carbonic acid must be introduced into the atmosphere daily, without taking into account the quantity expired by man and animals.

A much more important product of combustion is derived from the oxidation of the sulphur contained in coal and the introduction thereby into the atmosphere of sulphurous and sulphuric acids. In the researches undertaken by Dr. Thomson‡ during the last epidemic of cholera, which consisted in passing large quantities of the air of London through distilled water, it was found that such air invariably possessed an acid reaction, and that this reaction was due to sulphuric acid. Dr. Smith has further investigated this question, and has found that in Manchester the acid reaction of the atmosphere is much more constant and intense than in London. Blue litmus paper becomes red in half an hour, and sometimes in ten minutes when exposed to Manchester rain, and occasionally its acidity is such that a single drop is sufficient to effect the reaction. The actual quantity, however, is exceedingly small; of a solution containing a thousandth part of its weight of carbonate of soda, quantities varying from ten to fifty grains suffice to neutralise 1,000 grains of such rain; and as much cistern-water is found to be neutralised by twenty-five grains; from which results Dr. Smith concludes that the largest quantity of sulphur acids existing in the atmosphere of the town does not exceed 0·004 per cent. by weight, a proportion amounting to not more than a twentieth part of that of the carbonic acid. As to the share of sulphurous and sulphuric acids respectively in this total, it is of course impossible to arrive at a conclusion; but considering what we know of the rapidity with which the former is oxidised in the air, it is to be supposed that whenever the acidity of the atmosphere is marked, it will be mainly owing to the latter. The impregnation of the rain with the mineral acid must be regarded as rather beneficial to health than otherwise, as tending to retard the putrefaction of animal matter on which it falls.

Dr. Dundas Thomson appears to have been among the first to recognise the importance of organic matter as a constituent of the air of towns, and to express the conviction that the gaseous products evolved during putrefaction are not the main sources of danger. Proceeding on this idea, he subjected a large quantity of atmospheric air to chemical investigation, "with a view of condensing any vapour, or detaining solid particles, which might be disseminated." The result

* Daniell: *Philosophical Magazine*, Fifth Series, No. 121.

† Dumas and Boussingault: "Récherches sur la véritable Constitution de l'Air;" *Ann. de Chimie et de Physique*, troisième série, tome iii. p. 257. 1851.

* Roscoe: "On the Atmosphere of Dwelling-houses;" *Quarterly Journal of the Chemical Society*, October, 1857, p. 259.

† The researches of Hlasiwetz in 1836 (*Berichte der Wiener Akad. d. Wissens.*, vol. xx. p. 189), show that the sulphuric acid used for absorbing the moisture, on the one hand, absorbs aconsiderable portion of the carbonic acid from the air passed over it, which circumstance causes considerable variation in the results. On the other hand, the caustic alkalies which are employed for the absorption of carbonic acid, absorb considerable quantities of atmospheric oxygen. One should suppose that the improvements made of late years in the volumetric analysis of carbonates—which give results in every respect more accurate and expeditious than those obtained by weighing small quantities of gases in large apparatus—would deserve more extended application in the analysis of the air.—Dr. Hugo von Gilm, under the guidance of Hlasiwetz (*Berichte d. Wien Akad.*, vol. xxiv. p. 279), and D. Pettenkofer have contrived methods which leave nothing to be desired in this respect. It was also noticed, that when ozonised air was conducted through weighed tubes containing chloride of calcium, ozone displaced an equivalent proportion of chlorine, which being four and a half times heavier than the ozone, must necessarily cause very great variations in the result. This error is likewise avoided by a previous volumetric determination or absorption of the active oxygen. A further source of error in the determination of the amount of water in the air by means of sulphuric acid is the ammonia present. From all of this it will be seen that the examination of air by passing it through a series of weighed tubes containing alternately various absorbents can only give results which, to say the least, are very doubtful.

‡ Appendix to "Report of the Committee for Scientific Inquiries in Relation to the Cholera Epidemic of 1854," p. 110

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was entirely negative.* Further inquiries of the same kind were made, under the sanction of the Board of Health, in 1854, the air being passed, as has already been mentioned, through distilled water, the result invariably being that hyphaceous fungi made their appearance in the water, and in a short time, by their rapid growth, pervaded the whole of it, so as to be evident to the unassisted eye.† It was also found, that on passing the air through sulphuric acid in the same manner, the acid became soon dark coloured, in consequence of the charring of the organic matter introduced into it. Dr. A. Smith has worked out the idea much more completely. He has preferred a chemical to a microscopical test for the detection of the suspended organic matter. It consists, as most of our readers may be aware, in passing the air through a very dilute solution of permanganate of potash, the strength of which is determined by ascertaining how much is required to decompose a solution of a weighed quantity of oxalic acid, or of uncrystallisable sugar. This test obviously indicates, not the quantity of organic matter, but the quantity of oxidisable matter in the atmosphere, and hence it is only valuable in so far as we may assume that the atmosphere, contains no reducing agent. Thus, in the presence of sulphurous acid, it would be of little value were it not that the agent exists, even in the town air, in exceedingly small quantity. Many of Dr. Smith's results are of such a nature as to be beyond the possible limits of this source of error. It was found that the same quantity of the solution of permanganate which was decolorised by one bottle of air obtained in a close court in Manchester, required twenty-two bottles to decolorise it on the hills in the neighbourhood. Assuming that sugar and the organic matter of the air decomposed by the same amount of manganate, "a supposition which cannot be perfectly true, but which, from the minuteness of the amounts, leaves no room for a great error," Dr. Smith concludes that whereas, on the high ground north of Manchester, there existed but one grain of organic matter in 200,000 cubic inches, in close places in the town there was a grain in 8,000 cubic inches. From his most recent observations he concludes that we have, "in different air breathed by people in the same country, a substance the amount of which in one case is twenty-two times greater than in the other, and in air breathed by people in the same town a difference which is as 9 to 22."

The whole importance of these investigations, regarded from the point of view of preventive medicine, lies in their relation to the putrefactive process. To discover a means of seizing upon and estimating putrid exhalations—under which term we include everything not gaseous that is disengaged into the atmosphere from the surface of living animals, no less than the exhalations from dead animal matter—would be certainly a most important step towards acquiring a more satisfactory knowledge of the influence of habitation on health. We have, therefore, to inquire what grounds there are for regarding Dr. Smith's test, or any other founded on a similar reaction, as affording a solution of this problem. It is not difficult to satisfy ourselves that animal matter in putrefaction does disengage from its surface portions of its substance, of sufficient tenuity to be suspended in the atmosphere. Without referring to offensive smells, which of course must be material, we have several satisfactory proofs. If a bell-glass be inverted over decomposing animal matter in a moist condition, the inner surface of the glass becomes in a few days bedewed with moisture, which on being examined under the microscope is found to contain the same filamentous fungi to which reference has already been made; and on evaporation it leaves a residue, which is blackened by incineration. Similarly we find that the moisture which is deposed in glutinous drops on the sides and arched roofs of sewers, is rich in organic matter, which must clearly have been derived from the air of the sewer. Dr. Smith has related the results of experiments showing that air kept for a length of time in contact with putrescent matter, becomes loaded with oxidizable material, and acquires the power of decomposing a correspondingly large quantity of permanganate of potash.

Another group of facts shows us that the existence of putrescent impurity in the air is a principal, though not a necessary, condition of the induction of putrefaction in bodies susceptible of the change. Thus, for example, I have found that milk which retained its freshness for hours, will at once turn on being exposed to a putrid emanation. Butchers are familiar with the fact, that meat cannot be successfully dressed in the neighbourhood of a stinking gully-grate, or of a stable reeking with ammonia; and for the same reason, every intelligent butcher keeps his slaughter-house in a state of scrupulous cleanliness. It is not, however, to be forgotten that other causes, possibly electrical, the nature of which is still involved in obscurity, have a still greater influence in inducing putrefaction. Thus, in this country, the butcher finds that on one day he is able to slaughter and dress even veal or lamb with safety; whereas on another, not differing in temperature, incipient putrefaction may render the carcass unsaleable, in spite of the most careful precautions; butchers are apt to believe that this occurs mostly on calm days when the air feels heavy. Still more remarkable are the facts recorded respecting the slaughtering of cattle in hot countries; the operation can only be safely performed when the air is clear, and the sky cloudless. Under such circumstances we are told that the appearance on the distant horizon of a cloud "like a man's hand," the sure precursor of a storm, is a sign to the slaughterers on the Pampas of South America to desist from their work, for it is immediately followed by rapid putrefaction.

Air contaminated with putrescent matter is for the most part alkaline. Thus the air of sewers is invariably so, as has been proved by the experiments of Dr. Dundas Thomson, its alkalinity being owing partly to ammonia, partly to the sulphuret of ammonium, the form assumed by the sulphur disengaged in the composition of fæcal matter. The air of stables and stable dwellings is strongly alkaline, as everyone in attendance on the sick poor of London well knows; and the air expired by men and animals, although at first probably acid, becomes alkaline by putrefaction. The relation between putrefaction and the existence of ammonia in the air is therefore so close, that the detection of this body may, under ordinary circumstances, be regarded as a proof of its existence.

Bleaching Power of the Air.—It is known to those who are commercially engaged in air-bleaching, that the bleaching power of the air varies very considerably, not only according to the season and time of day, but irrespectively of such periods. It has not yet been determined what is the relation between this reaction and the oxidizing power of the air, as exhibited in its power of decomposing iodide of potassium. But the remarkable experiments of M. Houzeau (*loc. cit.*), made simultaneously in town and country, have shown that country air bleaches much more rapidly than town air, and that in this respect the difference is no less marked than in that of the well-known ozone reaction, which has been so clearly shown to be destroyed by urban contaminations.

The pressure, temperature, and moisutre of the air, are but little modified by habitation. The readings of the barometer and hygrometer in town and country do not differ. There is, however, one respect in which the temperature of great towns may be favourably compared with that of the country—viz., in that of equability. This subject has been very fully illustrated by Mr. Glaisher, in his Report on the Meteorology of London during the year 1854; and more recently by Professor Hennessy, in a paper read last year to the Association for the Promotion of Social Science. Mr. Glaisher found that in the middle of London the night temperature is much higher, and the day temperature considerably lower, than in the country, and consequently that the range of daily temperature is nearly twice as great in the country as in London, especially in clear weather, when the cloudless sky of the country contrasts with the smoky obscurity of town. This immunity from great variations of temperature must tend to diminish, though probably it does not at all counterbalance, the generally injurious effects of town air on persons affected with chronic pulmonary disease.

In the preceding paragraphs we have reviewed all the differences which are discoverable, either by physical or chemical means, between the atmosphere of towns and that of the country; and we are in a better position to determine, in the light of physiology, which of these conditions is likely to exercise most influence on the health of man. As regards the existence of an excess of carbonic acid, it is clearly of no importance whatever; for in many large towns no such excess is met with. Sulphurous and sulphuric acids, if they have any influence, must act as "colytics"—*i.e.*, as agents tending to arrest putrefactive change. The absence of sunlight, on which the more equable temperature of towns depends, has unquestionably an unfavourable influence, but one which is very limited. We are driven then to the only difference which remains—viz., that which depends on the existence of oxidizable matter, as indicated by its power of reducing certain metallic oxides.—*British and Foreign Medical Review.*

* "Chemical Researches on the Nature and Causes of Cholera;" *Medico-Chirurgical Transactions*, vol. xliii., 1859.

† "Report on Cholera," p. 127.

The Student.

AN ELECTRIC TELEGRAPH.

Many amateurs may be inclined to apply their electrical knowledge in establishing telegraphic communication, either between two sepa-

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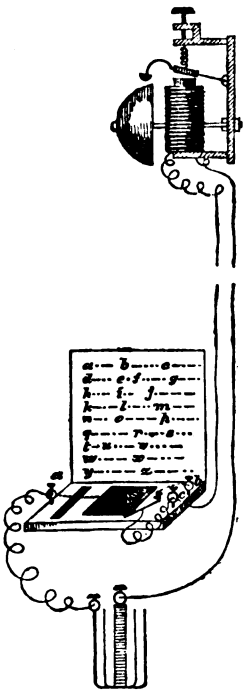
rate buildings, or from one portion to another of the same building. In the latter case, it will be necessary to employ a complete wire circuit, in other instances, it will generally be convenient to use the earth for one half of the circuit. We will proceed to describe a system of signalling, which, from its great simplicity and cheapness, offers peculiar facilities for the construction of private "lines" of telegraph by the student who has attained a certain degree of proficiency in electrical science. This system was suggested in 1845 by a gentleman now connected with this paper; but at that period it was considered impracticable to receive signals by sound. The fallacy of this notion, has since been fully established, and it is found that the eye becomes fatigued or confused by the movement of a needle, much more readily than the ear, by the sound of the two little tinkling bells, in the telegraph system of the Messrs. Bright, or by the click of the Morse instrument, which, from long habit, becomes perfectly intelligible to the operator. In the present plan, one bell only is adopted, which is caused to emit two distinct sounds, one by the hammer striking the bell sharply and momentarily, and the other by a prolonged contact of the hammer.



The arrangement of the electro-magnetic bell, given in the upper portion of the cut, will he readily understood. One arm only of the electro-magnet is represented, the latter being actually in the form of a horse shoe, or composed of two cylindrical pieces of soft iron, united at their lower extremities by a flat bar of the same metal. The arms of the magnet are coiled, either with a few layers of tolerably stout wire, if a current of considerable quantity is to be used, or with a long length of fine wire, if several small cells united for tension, are employed. The armature of the magnet, retained by an adjustable spring, carries the hammer which strikes the bell, and moves freely in a vertical direction upon a hinge. The bell is attached to a metal rod passing between the arms of the magnet, and fixed at the back of the instrument by a screw and nut.

So much for the receiving apparatus; the contrivance for transmitting signals is equally simple. Two pieces of metal, a broad and a narrow strip, are fixed upon, or sunk into, a slab or table of wood. These two pieces of metal are connected with the binding screw *a*, which receives the wire leading from one pole of the battery. The screw *b* is also connected with the strips of metal, while the screw *c*, is unconnected with the same. Through the latter passes a wire, from the magnetic bell apparatus at the distant "station," to which is attached a stylet of metal, *s*. In the case of a complete metallic circuit, the wire proceeding from the other pole of the battery is also directly connected with the bell apparatus, as indicated in the figure. When the stylet *s*, is inserted in the binding screw *b*, the circuit is completed, and the armature of the magnet will be attracted. The method of transmitting signals is as follows:—to indicate a *dot* in the alphabet, the stylet is drawn across the narrow strip of metal attached to the slab; and the circuit being momentarily completed, the hammer strikes the bell producing a *sharp* ring. To indicate the dash the stylet is drawn across the broad piece of metal, and the bell is rung with a *dead* sound, consequent upon the prolonged contact of the hammer.

In fitting up two stations for receiving and transmitting communications, each operator will have both a table with alphabet and a bell apparatus, and two of each must, therefore, be placed in circuit. When signals are to be received, the stylet is attached to *b*, and at the distant station the circuit may then be broken or completed at will. When the earth is used as half of the circuit, the wire leading from one pole of the battery is led to earth, and the other wire constitutes the "line," which, ultimately, after traversing all the instruments, is also connected to earth.

Meteorology.

CHANGES OF WEATHER.

[From the Times, April 11.]

The public have not failed to notice, with interest, and, as we much fear, with some wicked amusement, that we now undertake every morning to prophesy the weather for the two days next to come. While disclaiming all credit for the occasional successes, we must, however, demand to be held free of any responsibility for the too common failures which attend these prognostications. During the last week Nature seems to have taken special pleasure in confounding the conjectures of science; and while we, resting upon grave authority, have been made to promise fine weather, the heavens have bestowed upon us a week of fog and deluge. The Thames has been everywhere overflowing its banks, and has been washed into a state of temporary cleanliness even here in London. The gutters of the streets have hardly ever ceased to run, and cabs and omnibuses have been so constantly in request, and their straw and cushions have been uniformly so wet, that lumbagoes and catarrhs are mastering the industry of apothecaries. "*Jam satis terris*" has been the only ode that has occurred to schoolmasters or schoolboys, umbrellas are at a premium, and Jupiter Pluvius has had the whole sky to himself. Yet during this time we have been daily promising fresh breezes and fine weather day after day, and our weather prophet has only once permitted himself to foretell that on one day—Sunday last—it would be rainy in Ireland. In the face of all this we are afraid we cannot stand up with good conscience for the actual value of the prophetic powers with which we have been recently endowed. But, although we are only the mere "medium" of prophecy, we have still enough of that obstinacy which belongs to all modern prophets, from Dr. Cumming to the last foreteller of the Derby, not to give the case up, and to attempt satisfactory reasons why events have not altogether verified our predictions.

Admiral Fitzroy has, as we have fairly admitted, been for the last few days very ill-used by the weather. If he had trusted to the doctrine of probabilities, instead of to his telegraphic reports, chance would probably have used him better, and could not have used him worse. But these failures do not in any degree detract from the importance of the labours in which he is engaged, or from the probability of ultimate success. It is not necessary to impress upon a people whose earliest salutation in the morning, and whose common talk of topic throughout the day is derived from the weather and its operation upon all their avocations, how useful it would be if we could get a few hours' notice of its probable vicissitudes. The desire is so general that it is everywhere the parent of a hundred superstitions. Some men swear faithfully by a weather-glass which has gone on deceiving them for forty years; others, more cynical, consult their barometer, and believe the opposite to what it says, with about the same average result. Some, again, are satisfied to inquire whether there is any pic-nic, or flower-show, or horticultural fête, or volunteer review fixed for that day, and to lay aside their greatcoats and umbrellas if assured that no such direct provocation of a deluge is operating. Now, however, an attempt is being made to treat this matter in a scientific way, and to see whether we really cannot arrive at some approximate knowledge of the laws by which the fall of rain is regulated. In so novel an inquiry, of course our first guesses must be but guesses. All that is to be required at setting out, is that our observations should be made with care and impartiality, and that our forecasts of the future should be made upon some principle which the results may either establish or destroy. "Certain it is," says Admiral Fitzroy, "that, although our conclusions may be incorrect, our judgment erroneous, the laws of nature and the signs afforded to man are invariably true. Accurate interpretation is the real deficiency."

The success which Admiral Fitzroy has already obtained, and the practical good he has effected, are quite sufficient to justify us in allowing him to continue his experiments at the very moderate cost which they occasion. There can be no doubt that, by a system of observation, which is not altogether his own, he can at present foretell any great and unusual disturbance in the atmosphere; and that he can, by an organization which is entirely his own, give such warning all round our coasts as renders the occupation of our fishermen far less perilous, and will, all round our islands,

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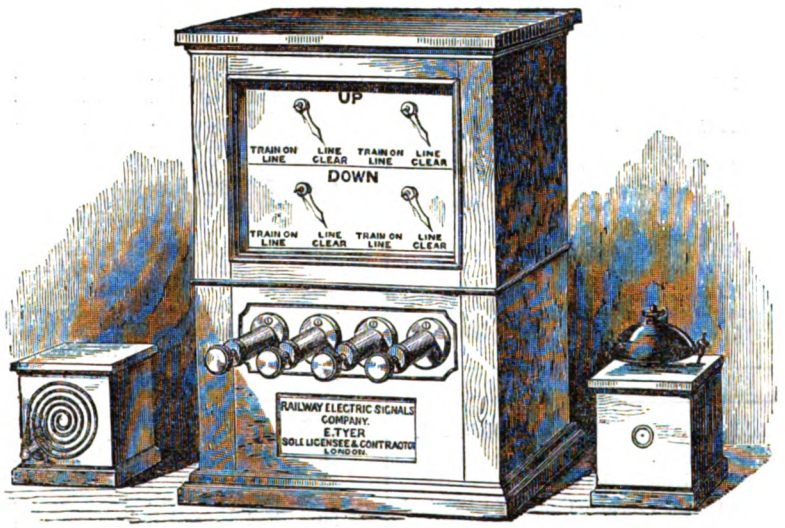
reduce to a *minimum* the operation of storms. In the report which has just been published by the Board of Trade, the Admiral very fairly takes credit for many escapes arising entirely from attention to his signals, and he cites several fatal effects of inattention to those signals at times when the sun was bright and the air serene. These storm drums are now obtaining the faith they deserve. Occasional false alarms, although they still naturally excite ridicule, no longer occasion utter incredulity, and seamen no more like to go to sea when one of the Admiral's drums is hoisted than they like to go to sea on a Friday. The Admiral does not undertake to fix the exact hour at which a storm shall burst over any particular spot, he merely warns of danger. "But, say some, and justly," says the Admiral in this report, "are ships to remain waiting to avoid a gale that, after all, may not happen? Are fishermen and coasters to wait idle and miss their opportunities?" By no means. All that the cautionary signals imply is—"Look out;" "Be on your guard;" "Notice your glasses, and the signs of the weather;" "The atmosphere is much disturbed." A forecast of the weather is obviously a much more delicate operation than the forecast of a great storm; and any great success in such predictions would obviously argue a much greater advance in our skill in calculating meteorological phenomena than we at present possess. The Admiral thinks he has discovered a law from which great results may be ultimately attained, and the future state of the weather indicated. He has ascertained that in our latitudes there is a continuous alternation of air currents, moving circuitously, as it were, in a separate system; but that, while these currents are passing and repassing among themselves, the whole body of atmosphere in which they operate is moving incessantly towards the East, at an average rate of about five geographical miles an hour. It is upon this law, if we understand him correctly, that Admiral Fitzroy builds his hope of being able to tell us what winds and what weather will arrive at any particular spot at some approximately indicated time. Having accurate observations at outlying stations of the various currents, having these observations instantaneously communicated by telegraph, and calculating the disturbing forces operating upon the average easterly progression of the atmosphere, he brings out a conclusion as to when the wind and weather he knows to be at one spot will arrive at another. This conclusion will obviously be more or less correct, according to the skill or knowledge with which the calculator appreciates the action of his meteorological agents.

It is easy to see from this, that however correct the Admiral's principle may be, there are many good reasons why it should not yield practical results until long observation has taught us better how to work it. "The facts now weighed and measured mentally, in what may be correctly called 'Forecasting' weather, are the direction and force of each air-current, or wind, reported telegraphically to the central station in London from many distant stations, their respective tension and temperature, moisture or dryness, and their changes since former recent observations." Admiral Fitzroy thinks there are reasonable grounds for expectation that he will soon be able to measure these forces, not by a mental estimate, but by mathematical analysis and accurate formulas. If so, it may come to pass that the generation now newly born may learn at school to work out the weather of to-morrow as surely as generations, past and present, have calculated eclipses. This is what Admiral Fitzroy hopes to effect. That he has not done it yet the contradiction afforded to his forecasts by these rushing floods too sadly testifies. What he has done is, to save a great many fishermen's lives, and to disseminate the knowledge of the use of the barometer. Even as a rain weather prophet there is no reason why the Admiral should be discouraged by anything that has yet happened. Science is acquiring new arms every day, and they who follow her faithfully need not utterly despair of wresting even such a secret as this from Nature.

RAILWAY SIGNALLING INSTRUMENT.



In a late number a correspondent, a "Practical Telegraphist," pointed out the advantages derived from the adoption of an efficient system of railway signalling. We now place before our readers an arrangement invented and patented by Mr. Edward Tyer, and which is extensively employed upon various railways. The instruments will shortly be fixed on the Brighton line, between Hassock's Gate, Clayton Tunnel, and Brighton. The following is a description of the system and instruments:—

1. The line of railway is divided into certain portions or signal stations, and no train is to be permitted to pass one of these signal stations unless a notification of the line being clear has been received from the signal station in advance.
2. Each signal station communicates with the signal station on either side of it, so as to announce the approach and departure of every train.
3. The receiver of a signal cannot alter it; the sender alone is enabled to reverse it.
4. The signal once given remains fixed until the next signal be sent, and can therefore be referred to any moment.
5. The dial of the instrument is divided into two parts; the upper part being for the up line, the lower part for the down line; each part has two needles or indicators, one black the other red. The black indicator is the last signal received at the station. The red indicator is the last signal sent from the station.
6. Each instrument is also furnished with a bell and gong.
7. Only two signals are used—"train on line," and "line clear."

Extract from Captain Tyler's Report to the Board of Trade on the Collision in the Clayton Tunnel of the London, Brighton, and South Coast Railway.

"Of the different systems that have been proposed and used from time to time, I may particularly specify Tyer's patent, which is in use on the South-Eastern Railway, as being one of the most perfect. The apparatus for the use of the signalmen comprise a telegraph needle for each line of rails in each direction, and a bell and gong, having different sounds, the one for the up and the other for the down line of rails in each direction. The bell or gong is used to draw attention to the approach or passage of a train, and, by the number of beats employed, to describe the train; while the needles are used solely to denote either 'line blocked,' or 'line clear;' and no signalman can alter his own instrument, it being the duty of each signal-man to work the needles of each signal-men on either side of him."

Colonel Yolland, in his Report to the Board of Trade on the accident on the Hampstead Junction Railway, states:—"To prevent similar accidents in future, I would recommend: First, that the telegraphic system of signalling should be extended on to Kew, and that the regulation of not permitting a train to pass a station until the telegraphic signal 'line clear' has been received from the station in front, as followed on the North London Railway, be adopted, in preference to the practite on the London and North Western Railway, which, in my opinion, is not sufficient under all circumstances to prevent a collision from taking place."

A set of the instruments are now at work on the Kew line.

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COCKER'S PATENT CAST STEEL ROPE WIRE.

In a recent number (16) we inserted a table of the size, weight, length, and strength of iron wire. We now give the same information relative to steel wires.

Table of the Size, Weight, Length and Strength of "Cocker's" Patent Cast Steel Rope Wire,

In Lengths from 10 to 40 Pounds, and Warranted to Twist round its own Diameter.

Rope Wire Guage.	Diameter.	Weight of 100 Yards.	Length of 1 Cwt.	Average Breaking Weight.	
				"Cocker's" Patent Cast Steel Rope Wire.	Iron Wire.
No.		lb. oz.	Yards.	lb.	lb.
4	·246	48 6	228	6828	3620
5	·226	41 0	273	5474	3040
6	·198	31 4	358	5320	2510
7	·183	25 12	434	4501	2220
8	·175	24 12	452	4074	1840
9	·160	20 6	549	3416	1560
10	·136	14 13	756	2751	1280
11	·128	13 3	847	2457	1000
12	·107	8 12	1275	1869	800
13	·100	7 12	1427	1575	568
14	·092	6 0	1856	1218	456
15	·079	4 14	2297	1000	352
16	·070	3 12	2961	826	264
17	·063	3 0	3694	700	208
18	·057	2 5	4813	521	160
19	·047	1 14	5973	381	128
20	·042	1 6	7964	297	104

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

March 18th, 1862.

J. C. Dyer, Esq., Vice-President, in the Chair.

Dr. Joule made a communication "On the Probable Cause of Electrical Storms."

The very close correspondence between the theoretical rate of cooling in ascending, and the actual, indicates a rapid transmission of the atmosphere from above to below, and *vice versâ*, continually going on. We may believe that during thunderstorms this interchange goes on with much greater than ordinary rapidity. At a considerable distance from the thundercloud, where the atmosphere is free from cloud, the air descends, acquiring temperature according to the law of convective equilibrium in dry air. The air then traverses the ground towards the region where the storm is raging, acquiring moisture as it proceeds, but probably without much diminution of temperature, on account of the heated ground making up for the cold of evaporation. Arrived under the thundercloud, the air rises, losing temperature, but at a diminished rate, owing to the condensation of its vapour to form part of the immense cumulus cloud which overcasts the sky on these occasions. The upward current of air carries the cloud and incipient rain drops upwards, but presently, in consequence of the increased capacity of the mass from the presence of a large quantity of water, the refrigeration of the air, in consequence of its dilatation, will be so far diminished as to prevent the condensation of fresh vapour, and ultimately to redissolve the upper portion of the cloud. This phenomenon, which has been noticed by Rankine in the cylinder of the steam engine, will account for the defined outline of the upper edges of cumulus clouds. The upward current, no doubt, extends occasionally to regions below the freezing temperature. If cloud be carried with it, snow or hail will be formed, which, if sufficiently abundant, will pass through the cloud and fall to the ground before it is melted. Now, the dry cold air in which the snow and hail are formed is a perfect insulator. Ice has also been proved, by Archard, of Berlin, to be a non-conductor and an electric. Even water, in friction against an insulator, is known from the experiments of Armstrong, explained by himself and Faraday, to be able to produce powerful electric effects, and this fact has been suggested by Faraday to explain powerful electric effects in the atmosphere. Sturgeon has noted the remarkable development of electricity by hail showers. Few heavy thunderstorms occur without the fall of hail. Hail, whether in summer or winter, is almost, if not invariably, accompanied with lightning. In the presence of these facts it seems not unreasonable to consider the formation of hail as essential to great electrical storms; although, as has been pointed out by Professor Thomson, very considerable electrical effects might be expected from the negatively charged air on the surface of the earth being drawn up into columns, and although, as the same philosopher has observed, every shower of rain gives the phenomena of a thunderstorm in miniature. The physical action of insulators and electrics in mutual friction must certainly produce very marked effects on the grand scale of nature. If we suppose that the falling hail is electrified by the air it meets, the electrification of the cloud into which the hail falls might thus be constantly increased until the balance between it and the inductively electrified earth is restored by a flash of lightning. If the hail is negatively electrified by the dry air with which it comes in contact the latter will float off charged with positive electricity, which may account for the normal positive condition of the atmosphere in serene weather, as well as the electrification of the upper strata evidenced by the aurora borealis. The friction of wind has been supposed by Herschel to contribute to the intense electrification of the cloud which overhangs volcanoes during eruption.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	2s. 1d. to 2s. 2d. per lb.
Negro	1s. 1d. ,,
Java	1s. 5d. to 1s. 6d. ,,

Gutta Percha.

Seventy tons sold at public sale at Amsterdam on the 10th instant, at prices equal to—

First quality	2s. 7d.
Second ,, ...	2s. 5d. to 2s. 8d.
Third ,, ...	2s. 0d. to 2s. 3d.
Fourth ,, ...	1s. 10d.

Nearly all bought for London account.

April 17, 1862. Wm. Kirkmann.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do. B 7 per cent. till 1862 .	all	18 to 20	———
20	Do. C. ,, ,,	all	9 to 11	———
10	Channel Islands Telegrap .	all	———	———
Stock	Electric Telegraph . .	100	98 to 101	99¼
25	Do. New	15	— dis.	———
5	London District Telegraph .	4½	3¾ to 3¼ dis.	———
10	Mediterranean Extension Tel.	all	3½ to 4½	———
10	Do. 8 per cent. pref. . .	all	———	———
20	Red Sea and India Telegraph	all	19¾ to 19½	19½
1	Submarine Telegraph, scrip.	all	8/8 to 8/8	———
1	Do. registered . . .	all	8/8 to 8/8	———
10	Do. ,, . . .	all	4 to 6	———
2	Telegraph to India . .	1	½ dis. ¼ pm.	———
5	United Kingdom Telegraph .	2¾	1½ to 0½ dis.	———

Telegraphic News.

MALTA AND ALEXANDRIA.

On Friday evening Mr. Richard Glass, of the firm of Glass, Elliot, and Co., was entertained at a dinner at the Clarendon Hotel, as a well-merited recognition of his services in the promotion of ocean telegraphy, and more especially upon his return from completing the important works in connection with the laying down of the Malta and Alexandria cable, and the deep sea line between Toulon and Algiers. The success of the latter line is peculiarly interesting at the present moment, when efforts are being made to resuscitate the Atlantic scheme. The length of the Toulon and Algiers cable is 600 miles, and the average depth in which it is submerged 1,600 to 1,800 fathoms, while it is believed that no portion of the Atlantic line will exceed a depth of 2,500 fathoms.

The chair on the occasion was occupied by the Honourable Robert Grimston, the (chairman of the Electric and International Telegraph Company), and supported by Lord Otho Fitzgerald, the Right Hon. J. Stuart Wortley (the chairman of the Atlantic Telegraph Company), General Wyld, C.B.,

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Sir Charles Bright, Captain Galton, R.E., F.R.S., Messrs. G. P. Bidder, F.R.S., Mark Phillips, Richard Till, W. H. Smith, T. Crutchley, C. Fleetwood Varley, E. Bright, C. V. Walker, F.R.S., J. Crampton, George Saward, &c., &c.

THE LONDON AND QUEENSTOWN DIRECT TELEGRAPH COMPANY (LIMITED).

The communication is now completed between Cork and London by the submarine and land wires of the above company, and several instances have already occurred in which the utility of the line has been appreciated by our great commercial interests.

A new company is in course of formation for the construction and maintenance of a submarine line of telegraphy between Ireland and Halifax Nova Scotia, with land lines to New York and the principal Canadian towns, and ultimately to Victoria, the capital of British Columbia.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

INDUCTIVE RESISTANCE.

To the Editor of The Electrician.

Sir,—Mr. Webb has not thought it well to notice a question I put to him in a letter published by The Electrician, of March 28, unless, indeed, he intends the reply to be indirectly given in his memoir of the last number; if it be so, I am bound to say it is not satisfactory. I did not doubt that algebra could work out results from any premises whether true or not, but I wanted to be told whether the results of his calculations are put forward only *as such*, or also as being in accordance with observation. If Mr. Webb does not know, he should be told that *they are opposed to facts*. I mean this remark to apply both to the case I then alluded to and also to the fresh one since given.

In the case of the two Volta's condensers, illustrated by Fig. 49 (page 269), we are asked to "let it be supposed," of the charged pairs of plates, A B and C D, that the inductive action will take place *practically* entirely between their opposing surfaces;" and the result of reasoning thus founded we are required to receive as coincident with fact, whereas observation proves that in such cases there is an induction from the inner surfaces of B C, and a more energetic one from the outer surfaces of A D, the latter becoming greater up to a certain limit, as their distances from B C, respectively, are increased. On account of that induction the plates, A B C D, can under no circumstances have "equal" charges to begin with, as it has been assumed. Nor is it a fact that the accumulation on C D is diminished by separating A B further from one another, although the charge of the two latter is thereby made smaller. Neither will the extension of A B into A″ B″ alter the induction between them in the way represented. Mr. Webb is forgetting that A is in conducting communication with the "source S;" what effect the removal of that communication would have upon the theory I leave its author to say, being only careful that it lean not for support on false facts. Resistance to electrical induction is a practical reality, as every one knows, but Mr. Webb appears to me to be handling it in the dark, which, perhaps, he would no longer do if he took time to make himself acquainted with the *cause of charging capacity*, he might thus gain deeper views of resistances, and probably truer ones, for they would bear to be tested by observation.

I forbear to comment on the case of the two Leyden jars, fig. 50, as it is a mere repetition under another form of the two condensers; but I will do so on an early occasion, if it be required. Au Revoir.

April 12th, 1862.

P.S. In my letter to you of last week your compositor makes me say we are in want of a causation for reasoning facts together into a *thing;* I wrote *string*, your readers will hardly think the more comprehensive expression the better of the two.

RAILWAY SIGNALLING INSTRUMENTS.

To the Editor of The Electrician.

Sir—The system your correspondent, "Inquisitor," describes as the "most dangerous" he has met with, is certainly one which no one at all acquainted with the subject would recommend, but to exchange even so faulty a system for the one "Inquisitor" advocates, would, in my humble opinion, be "no improvement." Bright's bell-instruments, doubtless, answer admirably the purpose for which they are employed by the Telegraph company referred to, but to depend on "sound" for "tunnel signals" would be, I think, "decidedly dangerous."

The "train signal system," recommended by "Mr. Newman" is the most perfect tunnel telegraph I know of. It is at once simple and effective. The indicators are ordinary "needles," or "pointers," not worked by a "relay," but acted upon by the current direct.

Each line, "up" and "down," has a separate and distinct indicator, and by a single movement of the needle the pointer is brought immediately over the words, (plainly printed on the dials), "Train on line," or "line clear."

Suppose a train on down line at A entering the tunnel on way to B, A rings B's bell, and holds over the down line needle to "train on line." B acknowledges the signal by "blocking" the down line needle to "train on line."

When the train has passed out of the tunnel B rings A's bell, and holds needle over to "line clear;" A acknowledges the signal by "blocking" over to "line clear," and so on for the up line; thus the needles are "always blocked" to "train on line," or "line clear."

A vertical needle, from whatever cause, indicates, "line blocked."

The alarum is worked by a separate wire, and is used as a "call" only. Bells which require no "winding up" can be employed.

I know of a number of the "train signal instruments which have been in constant work, day and night, for the last five years.—I am, sir, yours obediently, T. C. J.

April 8th, 1862.

TRAIN SIGNALLING INSTRUMENTS.

To the Editor of The Electrician.

Sir,—Referring to "Inquisitor's" letter in your impression of the 4th inst., I may remark that the signals made by one needle are always indicated either by the top or bottom pointer, according to preconcerted arrangement. If the top pointer is adopted, then the bottom is disregarded altogether, and, *vice versa*, hence the confusion which "Inquisitor" imagines is caused by a needle making two signals contradictory to each other cannot arise. For various reasons, alarums should not be required to give intelligible signals, but be used simply to call attention to the needle instrument. Herewith I beg to send you Mr. Edwin Clark's pamphlet on "Train Signalling," and you can, if you think proper, print extracts from it for the benefit of your readers.

I have superintended the working of this system on a portion of the London and North-Western Railway since November, 1855, when it was first employed, and it has always performed satisfactorily. Six years' trial on such a line is a good proof of its efficiency.—Yours obediently

Manchester, April 4th, 1862. Geo. W. Newman.

[We shall insert in a future number extracts from the pamphlet referred to.—Ed. E.]

To the Editor of The Electrician.

Sir,—Your correspondent, "D. Tunks," (misprinted "Sunks,") will find very thin strips of gutta percha will answer admirably as a substitute for gold-leaf, and these strips are very easily manipulated.

April 14th. Percha.

To the Editor of The Electrician.

Dear Sir,—A practical man tells me that in the electrotyping process deposits are not so good when the copper connections are completed with solder, as when they are unsoldered. Can this be so? And if so, why?

2. A telegraph needle, when facing north, hangs over to the east; when facing south it hangs vertically. What is the *rationale* of this?

3. Your correspondent, "H.T." (Bath), in No. 22 of The Electrician, would greatly help me, and perhaps other amateurs, if he would furnish a little further information as to the bell-mouth top to his flat gutta percha cell; is it really a top? And if so, is it only of use to pour the mercury and dilute acid into the cell?

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4. What is the "usual way," to which he alludes, of "cleansing the zincs?" All the cleansing which I can effect is by a solution of 1 of sulphuric acid to 5 of water. Is this the best and speediest mode?

5. I am anxious to know whether the table of diameters of iron wires, published in No. 16 of The Electrician, is correct for *copper wires?* and whether the diameters of higher gauges of wire can be furnished by any of your correspondents?—Believe me, dear sir, yours very truly,

L. L. S.

[1. Your practical friend has based a conclusion upon insufficient premises. It is a common mistake in electro-plating articles of small size to employ too much battery power, in which case the deposits are not so good as when smaller surfaces in the battery elements, or greater resistance in the circuit, are used. An imperfect joint may offer great resistance, and thus reduce the quantity of electricity traversing the circuit. Hence the particular result. 2. Is the axis of the *magnetic* needle (vertical) in the meridian when the telegraph needle hangs over to the east? We fancy the axis must then point somewhat to westward of the true magnetic pole. 3. The use of the bell mouth to the narrow gutta percha cell appears to be simply for convenience of inserting the fingers to remove the plate, and to hold the surplus fluid when the plate is immersed. 4. Your method of cleaning zinc plates is that which is generally adopted. 5. As far as it goes, the table applies to the number and gauge of copper wires.—Ed. E.]

Miscellanea.

Talk about the Telegraph.—Proper people find it difficult to amuse themselves in Lent; and this is possibly the reason why we saw announced the other morning in the *Standard* that:—"Mr. and Mrs. Blank have issued invitations for a *conversazione* on the subject of uniting America and England by the electric telegraph between Ireland and Newfoundland." The transatlantic telegraph, and the thousands that were sunk with it, afford a fitting topic to be talked about in Lent, which is for Christian minds the aptest time for penitential preaching. But though long faces were, no doubt, pulled at the *soirée* above-mentioned, still persons who were interested in telegraphic matters might have found grounds for consolation in the following announcement, which had appeared a day or two before in the *Observer*:—"A short time since we stated that a proposal had been made for very considerably reducing the time required for the transmission of telegraphic messages between this country and the south of Ireland. The outward and homeward American mails now touch at Queenstown, and receive or land their mails and despatches. Hitherto the news from America has been taken by steamer from 'Roche's Point' at the mouth of the harbour, up to Queenstown, and thence, if intended for London, by telegraph, *viâ* Cork, Dublin, Belfast, Doneghadee, Portpatrick, Dumfries, Carlisle, and Liverpool. This roundabout mode of sending telegraphic messages, of course produces many delays, for rapid as is the electric spark when fairly on its way, it must obey the stern orders of its masters, stop at the appointed stations, and wait till the line is signalled to be 'all clear.' Of this series of delays one has already been removed. The telegraphic despatches are now sent direct from Roche's Point. The despatches are made up at New York or Boston direct to this point, where they are opened and start directly on their journey, without having to make another stage upon the little panting, puffing steamer that runs to the Cove of Cork. A delay of an hour and a half is thus avoided, and the last American news was received in London in time for the second edition of our daily contemporaries, and the telegrams which were published in the *Observer* of Sunday last were given to the public nearly two hours sooner than they would have been but for the completion of this small section between Roche's Point and Queenstown." If we can't bridge the Atlantic with a telegraphic wire, at least we may abridge the time it takes to forward a message *viâ* Ireland; and what further steps are being taken for this end, the following will show:—"The other portions of the project, which include the construction of a telegraphic overland line between Cork and Waterford and Wexford, are being pushed forward very rapidly. From Wexford the telegraph becomes a submarine line, and will cross the Channel to St. David's Head, on the Welsh coast, and be continued *viâ* Milford to London. When completed, the average saving in point of time will be equal to nearly four hours. About fifty miles of the overland wires have already been erected by Messrs. Silver and Co., between Cork and Wexford, and the whole of this section will be completed in a few days. The wires are supported upon ebonite insulators, and the experience which has already been obtained proves that those insulators possess great superiority over those made of porcelain, glass, or other partially non-conducting substances. In one part of the new telegraph route it has been necessary to cross a small tidal arm running into the harbour of Queenstown. The cable which has been made for submerging at this point is of extraordinary dimensions. Its weight is upwards of seventeen tons to the mile, and is formed of eighteen thick protecting steel wires, enclosing eleven conductors, each of which is made up of seven strands of copper wire. These are insulated with india rubber, and it forms one of the most perfect and complete specimens of insulation which has yet been made for the purpose of submarine telegraphy." If Messrs. Silver be successful in their present undertaking, we trust that before long they may be so in a larger one; and that the "great superiority" of their ebonite insulator may enable us to hold discourse with distant countries more swiftly than at present we are competent to do. If they continue to improve our means of wiredrawn intercourse, we may be able before long to waft a sigh, by telegraph, from Indus to the Pole, and possibly transmit a kiss (in writing) from Calcutta to Cornhill. "Speech is Silver," say the moralists; and whatever tales we have to tell the submarines, no doubt the Messrs. Silver will enable us to tell them.—*Punch.*

The Submarine Telegraph Company have twenty-two lines to the Continent, including through routes to all the European capitals. They transmit on an average between 1,000 and 1,500 messages daily, and they possess the only direct lines to the Continent, *viâ* France, Belgium, Hanover, and Denmark, exclusive privileges having been granted to the company by these Governments for a period of thirty years.

It is a common error to suppose that birds are often killed by settling on the wires, and accounted for by the idea that they are struck down by the electric fluid passing through them. This is not possible, unless they touch two wires, and thus form a connecting medium, through which the electric current might pass. As they simply settle on the wire, the current continues on its way, preferring the metallic medium to that offered by the body of a bird. But if a bird had one leg on the wire and the other upon the ground, the electric fluid might be arrested in its course, and pass, through the body of the bird, into the ground; it is well known, and has been before-mentioned, that electricity invariably takes the shortest route it can find, and it is, therefore, only reasonable to suppose that it would do so in the instance under consideration. In such a case, if the electric current was of a sufficiently powerful nature, death would doubtless ensue, and the bird would present the appearance of having been killed by a stroke of lightning. Such an event is, however, not known in Great Britain, owing possibly to the fact, that none of our birds possess legs eighteen feet long!—*Dodwell's Handbook to the Electric Telegraph.*

Dr. G. C. Wallich, who went out as naturalist in the summer of 1860, in H.M. steamer Bulldog, during the survey of the proposed telegraphic route to America *viâ* Iceland, Greenland, and Labrador, is about to publish his observations in a work entitled "The North Atlantic Sea-bed." It will comprise a diary of the voyage, an account of deep sea-soundings and sounding apparatus, observations on animal life at extreme depths in the sea, and a detailed history of the various organisms discovered. The book will be illustrated with numerous plates.

To Correspondents.

Percha.—We believe that no advantage whatever is to be derived from testing cores in *vacuo*, and under hydraulic pressure in the course of manufacture, at least as far as the detection of *faults* is concerned. If the core is faulty, electrical tests properly applied must lead to its instant detection. All cores should be tested in water, in the first instance, at a low temperature, say 45°, and afterwards at a higher temperature, say of 65°. The difference in the insulation tests under the two temperatures, if the core be sound, will be in conformity with a well-ascertained law, which will be found in page 83 of this journal. We have seen lengths of india rubber core which had been subjected to tests in *vacuo*, and under hydraulic pressure, as a precaution before delivery to company for whom they were constructed. The effect of this testing was, that the cores, although passed as perfect, would not stand the ordinary tests applied by the company in question, and were consequently rejected and returned. We have described in a former number a series of experiments made with a view of ascertaining the effect of subjecting cores to the *vacuo* tests, &c. (see p. 200).

J. T. B.—We know nothing of the company you refer to, South Australia has supplied its own telegraphs, as might have been expected of an enterprising and wealthy colony.

P. Lewis.—The first "over-house telegraph was erected between London Wall and Birchin Lane, in 1857, for Messrs. Waterlow and Sons, and in 1858 extended to their premises in Westminster. The London District Telegraph Company was established subsequently.

P.—The Press and Telegraphy.—We will quote for your satisfaction the following statement from Mr. S. Smiles' valuable pamphlet on "Railway Property: its Condition and Prospects":—"The press has also done much to damage railway property. It has made it the subject of public discussion and animadversion more than any other description of investment. Railways have been assailed by misrepresentation of all kinds; and alarm has been skilfully excited against them, sometimes by those who had dashing articles to write, at other times by partizans of the different companies having their several organs in the public press; and all companies coming in for their share of animadversion by turns, the tendency of such writing was alike to damage and depreciate railway property of all kinds. Under the influence of alarming "leading articles," and equally alarming "letters to the editor," the public fears were thoroughly excited, the timid holders of shares rushed into the market to sell out at ruinous prices, and railway property suddenly became unpopular." To a less extent the same may sometimes have been the case in regard to telegraphy.

F. C.—Institute of Electricians.—See advertisement in the present number.

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The Electrician.

Vol. I. No. 25.—April 25, 1862.

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STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 279.]

166. The true theory of electrical force, whencesoever it may proceed, must inevitably embrace every fact discovered by observation, giving to it its natural implication. In this process it will inexorably absorb every prior sound inference that it meets with, and discard such as are unsound; but being neither helped on by the one class of doctrines, nor hindered by the other. It will be the theory of nature, which can borrow nothing; it must be competent to trace for itself the road it has to travel, and need not turn to the right hand nor to the left, to listen either to encouragement or caution. If physical creation be a reality, it must contain its own written history; if the universe be a chain of causes and effects, there must be in operation a force linking them all together; if the electrical phenomena be an orderly series of events, there must be written on their broad pages an originating causation. It is the mental perception of these things that alone is worthy to be called true theory, and though their discovery may be thought beyond the reasoning of man, it is not in his nature to be satisfied with any other stopping place. Surely the philosopher who has once grasped this view of theory as a truth, will never hesitate to acknowledge its supremacy, nor believe his facts have done their duty until they have led him to it; and if he be appalled at the vastness of the subject, let him only bear in mind how many and great are the conquests now achieved by the human intellect, which, in by-gone times, even to have attempted, would certainly have consigned him to Bedlam: he will then despair of nothing that is not set down by the self-evident principles of mechanical philosophy to be undeniably impossible, and in that category he will not find physical causation. There may be fifty avenues to failure, but while there is one open to success let us endeavour to find it.

167. We were led into this reflection by contemplating the relation which the present theory bears to the doctrines of Professor Faraday, with the wholesale manner in which it appropriates to itself his facts; and, though we consider that to have been unavoidable, we have concluded that unless we draw a line of demarcation around the ground he has trodden before us, it will be impossible to trace our theory into its details, without appearing to be unconscious of his extraordinary merits. We must, therefore, address ourselves to that task, and we hope to make it instructive.

168. Faraday was the first to teach that the particles of non-conducting matter generally, and of which we may take atmospheric air to be the type, arranged in lines either straight or curved, and abutting against a charged surface, are constrained by a force of induction to submit to a condition he has named polar, and which he conceives must consist in each particle presenting to the charge a face that is oppositely electrical, and turning outwards a face similarly electrical.

169. This state of insulating particles under induction, they being too minute to be subjected to experiment individually, he inferred from what was known by observation to be the electrical condition in small insulated conductors under the same inductive influence, each insulating particle being assumed to have the power of transferring electricity from one of its sides to the other, as by actual observation the insulated conductors were known to have. For it seemed reasonable to suppose that as insulated bodies of sensible magnitude in which this translation had taken place, could cause it in other insulated bodies of sensible magnitude, so the particles of insulators in which it had become established could set it up in other similar particles individually. The difficult part of the doctrine was the necessity it involved for believing that while electricity could not pass from one side to another of a mass of particles of insulating matter, it was able to pass from one side to the other of the same particles individually; and this was required to be granted.

170. The same authority further thought that the constraining force of induction, while propagating itself through matter in the direction of lines, was capable of expanding laterally, so as to establish itself along secondary lines, transverse to the principal ones; for without this addition there appeared no means of obtaining from the original conception that diffusion of inductive influence that facts obviously demanded; as, for example, when an electrical charge on the surface of a sphere is acting inductively on the surrounding atmosphere, with an intensity diminishing as the distance from the charged surface becomes greater.

171. No mechanical principles were assigned by which such a lateral action could be thrown out by the inductive force during its primitive linear progression; and, indeed, it would have been in vain to hope that any could be assigned so long as the nature of the inductive force itself remained uncomprehended. The lateral or transverse lines seem to have been tolerated purely for their necessity, without ever having been cordially entertained as possible; and their author has given us good reason to surmise that they would have given way in his mind to the simple idea of radiating lines of force, had it not been for the shorter radial lines that would then have become necessary, and for which there was no beginning seen possible.

172. The two doctrines which we have thus attempted briefly to describe introduced a third necessarily consequent upon them; for, inasmuch as inductive action was made to be the result of a *constraining* force, there was immediately involved the idea of *resistance*. Faraday accordingly tells us that it is necessary to regard the atmosphere as opposing the induction of a charge insulated in it," all the particles being considered as thrown for the time into a forced condition from which they endeavour to return to their normal, or natural state." Of course it would have been futile to theorize upon the possible nature of that resistance in the air, while the nature of the force overcoming it remained unknown; and therefore induction, with all relating to it, was abandoned to lay open its causation in some future light.

173. Those of our readers who have followed thus far the theory of static induction inculcated in these pages, will not need that we tell them how much it embraces of the preceding details, or what portions of them it discards; they will already know in which of the particulars we are in agreement with Professor Faraday, and as we proceed we shall avail ourselves of further opportunities for avoiding misconception on that point. Our immediate purpose will have been attained if we have made it clearly to be perceived that while his mind was impressed through a masterly analysis of experimental observations to infer the existence of contiguous induction, with its polarities, and a host of other consequences, but without tracing them to electrical attraction as the originating causation, we have been pursuing the opposite course of taking that attraction for our starting point, and by synthetical argument, based upon a particular view of it, and, guided in the direction of facts, have speedily fallen upon the same discoveries as a first and most obvious theoretical consequence.

174. Without the electrical law of quantity, as a law of force, we could have made no progress in our calculations of intensity,

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for the whole of our correspondences between theory and fact are derived more or less from that law. Faraday laboured under the disadvantage of being without it, or at least of regarding it simply as a law of phenomena; and hence he always spoke of the intensity of the induction falling simultaneously upon particles as varying with respect to any one of them in the simple inverse ratio of their number. This was consistent with the prevailing notions of electrical force, which assimilated it so far to the nature of light as to make it observant of the same law of dispersion which the student will understand if he refer to our fig. 3, and imagine light and the electrical force to be consecutively setting off from the vertex of the pyramid, and to be falling upon the four surfaces in succession, every compartment in each receiving an intensity denoted, not by the series of numbers which, with reference to electricity, our law of quantity has taught us to place in those compartments, but by the product of unity divided by the area of the whole of each of the surfaces. We give the following quotation, that it may be seen we are fully expressing the Professor's meaning:—"The theory does not assume that all the particles (of air sustaining electrical induction) are affected to the same amount. The idea is, that any section taken across the lines of inductive force and including all of them would be equal, in the sum of the forces, to the sum of the forces in any other sections." It will be recollected that, according to our theory the sums of the intensities of the particles at different sections taken across aërial pyramids or cones parallel with their bases, while under induction are very une ua l, as we have abundantly demonstrated.

175. In the above explanation Faraday plainly shows that he cannot altogether abandon the old idea of radiating electrical force; but it is not to be supposed that he holds any the less tenaciously, as an element of true electrical theory, to the propagation of force by particles of matter in lines, such as must be susceptible of arrangement in parallelism with one another, as when we conceive straight lines of particles to be assembled together in form of a cylinder, interposed it might be between the discs of a Volta's condenser. In illustration of this we might cite numerous passages from his writings if it were needful, and there is no doubt that as indistinct narratives of observation he perceived the true parts of both the doctrines, though in the absence of sufficient views of causation he was unable to reconcile one to the other.

176. "The theory," he says, "seems to supply an easy explanation of the influence of distance in affecting induction; as distance is diminished induction increases, for there are then fewer particles in the line of inductive force to oppose their united resistance to the assumption of the forced or polarized state, and *vice versâ*." The expression *united* resistance, even if other evidences did not make it clear, would show that the idea in his mind was evidently this: supposing the propagation of induction from a first to a second aërial particle to need an intensity in the originating charge equal to 1, then to propagate the induction from the second to a third particle will need an intensity in the originating charge equal to 2, and thus onward, the originating intensity being required to increase in the simple ratio of the numbers of aërial particles in the line along which the induction was to be propagated.

177. Now there cannot be the slightest objection to this argument, for it is quite obvious that effective induction must always be as great as the resistance overcome by it; that the induction must be the same at every point of the line, that is, wherever two particles are in contiguity; and that the total force of induction along the line must be equal to the sum of all its parts. But there is this to be remarked concerning it—it is applicable only to single, or parallel, lines, and not generally to induction setting out from charged convex surfaces insulated in the atmosphere, the phenomena of which it was supposed to explain.

178. Having said thus much, which the student who desires to become acquainted with the actual state of electrical opinions may profitably remember, we may proceed on our way, investigating our own theory in the light of facts; and they teach us that to arrive at a satisfactory conception of static electrical induction, competent to meet every exigency as it arises, we must admit that *electrical attraction can be projected through sensible spaces*, for the doctrine of a definite electrical attraction, though combined with the law of the squares of the quantities, will not be in certain cases adequate, if we restrict the propagation of its induction to the contiguity of particles. We have already had occasion to remark (par. 64), that the propagation of induction between particles in contiguity involves the idea of its projection through minute distances, and we have no good reason to doubt that electrical attraction can act across empty spaces of any extent, as assumed by the theorists of the last century. The truth really seems to be, seeking it by the teachings of this theory, in combination with facts, that *static electrical induction is, in the abstract, perfectly independent of aid from the contiguity of particles*, although by reason of the nature of attraction it must make use of that contiguity for the shortening of distance whenever the opportunity is afforded. Professor Faraday, moved doubtless by similar considerations, and while insisting upon the fact of contiguous induction, makes this precautionary reservation in the 1616th paragraph of his "Researches":—"Suppose it possible for a positively eclectrified particle to be in the centre of a vacuum an inch in diameter, nothing in my present views forbids that the particle should act at the distance of half an inch on all the particles forming the inner superfices of the bounding sphere, with a force consistent with the well known law of the squares of the distance." And again, in par. 1303, "There is perhaps no distance so great that induction cannot take place through it." So that he is not prepared to deny its possibility; and Sir William Snow Harris leaves the question entirely open by writing, "What would be the actual state or distribution of the electricity in a charged conductor, supposing it placed in pure space, and apart from all disturbing influences, it is really difficult to say."

179. Although the doctrine of contiguous propagation accords so extensively with the facts of induction when it occurs in our atmosphere, and we know of nothing in the nature of the electrical attraction that renders the presence of the atmosphere necessary to induction; still in this, as in other cases, we can pass from the region of probability into that of conviction only by an appeal to experiment, and fortunately our theory lays open to us means for proving experimentally that electrical attraction can overleap distance. We shall produce some evidence of this when we next address our readers.

(To be continued.)

RETARDATION IN SUBMARINE WIRES.

The retardation of signals in submarine wires is a question especially worthy of being treated and discussed in our columns. One of the most important points, in regard to the practical application of electricity—perhaps the most important in a commercial point of view, it is one of the weakest in electrical theory. Taking the question abstractly, we find Professor Thompson arriving at the conclusion that the time occupied in charging and discharging a cable, with its distant end to earth, varies, *ceteris paribus*, as the square of the length of the conductor. We are told that this conclusion has been verified by the highest mathematical analysis. A gentleman of some reputation as a telegraphic engineer was for a period under the impression that this "law" had been disproved by certain experimental facts; but it appears that this impression was speedily removed by the learned Professor. We cannot now enter into the course of argument which was in this case adopted; but with all reasonable deference to the *prestige* of a high scientific name, we imagine that no mathematical reasoning can be sufficient to overturn experimental facts which are adverse to the theoretical conclusion that has been advanced as a law. But, to continue our abstract view of

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the case, we will place before our readers, in his own words, and as given by Mr. Latimer Clark, the conclusion arrived at by Professor Thompson :—"I concluded that the rate of charging and discharging the cable must be proportioned to the square of the length; because for double or triple lengths, for example, the capacity is double or triple; and again, the freedom of entering and of getting out is reduced to half, or the double or treble quantity is to be charged with one-half or one-third of the facility of conduction, and therefore four times or nine times the time will be occupied." Mr. Clark states :—"The whole electricity in 200 miles (A C) will be exactly twice that in a 100 miles (A B). It will be seen at the same time that the average distance through which the electricity has to flow before reaching its destination, and before returning to the earth, is exactly twice the average distance which the electricity on (A B) has to flow; and, therefore, the longer cable (A C) not only has twice the electricity in it, but that electricity has twice as far to travel; and, consequently, the time occupied by the charge and discharge will be four times as long." We must confess that this appears to us unintelligible. We can readily admit that the supply of twice the quantity of electricity may take twice the period of time, but we do not perceive why the square of the number should be taken upon the grounds that the electricity has twice the distance to *travel*. If the battery can furnish the necessary quantity of electricity in two seconds instead of one, we surely are not called upon to believe that the transmission of this electricity is effected with such difficulty as to occasion the multiplication of the higher number by itself.

Before entering into the practical data which have been obtained upon this question, we will give a few extracts which mainly serve to show the unsatisfactory nature of the solutions which have generally been arrived at in regard to this important problem. In the Government Report, p. 23, we find :—"Most electricians who have considered this matter in a theoretical point of view, concur in stating that the time which is required for a certain amount of effect to be produced at the remote end of the wire, or, in other words, the time necessary to charge the wire to a certain amount, is proportional to the square of the length. Many attempts have been made to prove this law, but satisfactory experiments, free from error or ambiguity, are still wanting."

In the Minutes of Evidence, p. 11, in answer to an enquiry whether he had formed any opinion as to the ratio in which the retardation of the current increases with the increased length of the conductor, and as to whether it increases as the square, or in what ratio, Mr. Siemens states :—"This question is one of considerable intricacy. There are certain laws regulating the flow of electricity in the conductor; there is one law on the subject known by the name of Ohm's law; there is another law regulating the induction, or the charge of the insulating covering which regulates the resistance of conductors. Now, the retardation is the *product* of those two laws operating one against the other. If the cable is merely extended in length without increasing either the conductor or the insulating covering, the power of speaking through this cable will decrease very much in the square ratio of the length; but it is possible to construct a cable for any reasonable speed of communication through it, if scope is given to the proportion of the conductors and the thickness of the insulating medium to the length."

Mr. Whitehouse states in his evidence (Government Report, p. 71), "that, with the induction coil, a larger wire, *i.e.*, greater quantity in the current, gave in every instance a more rapid rate of signalling;" and adds :—"You must have a certain amount of intensity to overcome the resistance of the circuit; and if you go beyond that amount of intensity, you retard your current; in the first few miles you get a more rapid current; and in the last part of a long line it exhausts itself much more rapidly, the retardation being, under those circumstances, nearly as the square of the distance."

Professor D. E. Hughes differs very materially from Mr. Whitehouse, and states, page 82 :—"With the Red Sea Cable, of a length of 1,700 knots, nearly 2,000 miles, I could get 30 waves, the size of the wire was No. 11; *through* 1,000 *miles of the same cable, I could get* 50, *and through* 500 *miles I could get* 120 *in a minute.*"

Mr. Henley's evidence, page 109, is as follows :—"When to the 1,500 miles of Atlantic Cable another 1,000 miles were added, it appears to decrease of working immediately. It did not appear to me that what is understood as retardation (that is the delay in passage of current) was so much increased, but the current was rendered so feeble as to be scarcely sufficient to record the signals. This effect might be due to defective insulation."

Professor Thomson states (page 110) :—"If we can get three words a minute through 2,000 miles for example, through 200 miles there would be 300 words a minute possible; and I say that 300 words a minute are possible; but the excessive speed in every department of the work required for producing 300 words a minute, makes it economically impracticable to transmit at so great a rate through a telegraphic line however short."

Mr. W. H. Preece (page 134) says :—"The object of the experiment was to see the difference of retardation of signals with *different instruments*. I had a series of ordinary galvanometers, a series of relays, and a Bain's chemically marking instrument; the length of the current was 1,100 miles; upon using the relays we found that in a distance of 1,100 miles, before any signal could be registered at the distant end three seconds elapsed, but with a simple galvanometer it required only eight-tenths of a second. It was very curious that with one instrument I could not get the first appearance of the current until three seconds after I had made the contact, while with the other instrument the effect was obtained." The evidence of Mr. C. F. Varley is in favour of the law of squares, but points out that this must be greatly modified by any defect of insulation.

It appears to be generally admitted that a minute portion of electricity arrives almost instantaneously at the distant end of the wire when contact is made with the battery, and that this quantity becomes gradually increased; the propagation of the electricity along the wire to constitute its static charge, occuring in a manner which may be represented by curve. It must, we think, be allowed as a consequence of this and of other considerations, that the fact of a wire being or becoming charged does not occasion any retardation in the passage of electricity which does not become absorbed in the production of the inductive effect. Supposing one of two lengths of wire to be fully charged, the second length will become charged through the first, in the same period of time which was occupied in effecting the first charge, plus the infinitesimal period of time required by the electricity to traverse the first length. The fact that a continuous and gradual charging effect would in practice take place, does not render it necessary to assume that a different condition would prevail, and that a resistance would be set up which would give the square of the length, instead of its simple numerical expression, as the measure of the time occupied in producing the maximum dynamic effect at the distant end. It is to be observed that the portion of electricity which arrives almost instantaneously at the further end of the wire would, in the case of the shorter wire, be double in quantity to that in the longer wire, and that the same proportion prevails when the maximum dynamic effect takes place. It must be borne in mind, therefore, that the effect which is obtained, with the same battery power in every case, varies as the length of the wire.

We have given some reason for our non-adherence to the law enunciated by Professor Thompson, we have now, out of the few experimental *data* which have been furnished upon the question of retardation, to quote the experiments which appear to us completely to disprove this law.

Among these experiments, firstly, are those of Professor Wheatstone, given in the following extract from his supplementary report to the Board of Trade, which in several points of

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view, will be found instructive in regard to the present subject matter :—

"The following experiments show that when a discharge is effected simultaneously from a number of wires united at their discharging ends, the effect in producing the instantaneous deflections on a galvanometer is the same as when the wires are all united together to form one continuous length. No doubt when four miles of wire are simultaneously discharged, the discharge is effected in *one-fourth* of the time that it is from the same wires united continuously; but as the intensity is at the same time increased four times, the total quantity, which is the intensity multiplied by the time, remains the same, and produces the same deflection of the needle of the galvanometer.

"The battery of 504 elements and the galvanometer A were employed for these experiments.

——	In continuous length.	Side by side.
1 mile	7·5	7·5
2 miles.....	15·	15·
3 miles.....	22·5	22·
4 miles.....	30·	30·

"The duration of discharges from very long wires is too continuous to be measured by the maximum instantaneous deflections of the needle of a galvanometer."

The following results were obtained by Mr. Latimer Clark with the peculiar form of electro-magnet adopted in the beautiful instrument of Professor Hughes. It is known that the ordinary electro-magnet employed in Morse's printing instrument and in magnetic relays, takes some time to acquire, and also to lose its magnetic power. In the arrangement of Professor Hughes, two cylinders of soft iron attached to the poles of a permanent magnet are demagnetized by the action of a voltaic current, and the armature, the spring of which is so adjusted as merely to overcome the attractive force of the magnet, is thus released. By this means an action which, perhaps, constitutes one of the non-essential causes of delay in the transmission of signals, is removed :—

Length of Cable.	Number of Parallel Lengths.	Letter Printed.	Time in Thousandths of a Second.	Extreme of other Observations.
77 miles	1	B	25	
154 „	2	CD	45	
231 „	3	E	80	20
308 „	4	FG	115	10
385 „	5	H	140	144
462 „	6	I	160	164

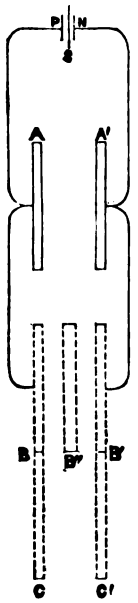
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 271.]

We have now to consider parallel and branch circuits. Let A A′ (fig. 51) be two equal opposing plates attached to the two sides of a source S, and forming an inductive circuit of a certain resistance, then if two similar plates B B′ placed the same distance apart as A A′ be joined to A A′ in the manner shown in the figure; the two sets of plates may be said each to form a branch of a divided circuit. Now the total inductive resistance of the whole circuit thus formed is evidently decreased by the

Fig. 51.



addition of the plates B B′, and since the plates B B′ are the same distance apart as A A′, the total resistance of the whole circuit must be the same as of a circuit formed of one set of plates whose distance apart equals that between A and A′, and whose surface equals the surface of A and B together, or distance between the plates being represented by l, the surface of A by S, and the surface of B by S′, then $R=\frac{l}{S+S'}$. The resistance will decrease therefore exactly as S + S′ is increased, and the quantity increases in the same proportion, or the quantity increases in the same ratio as the surface is increased. Now as every part of their surfaces are under equal conditions, the density must be alike throughout, and the total quantity will be distributed on the two sets of plates directly as their surface, or in fact inversely as their resistance. Now if the plates B B′ instead of being separated the same distance as A and A′ had been separated only to half the distance, as at B″, then from what we have already said, we may suppose this new resistance B B′ replaced by another pair of plates C C′ of the same distance apart as A A′ and of such a surface that their resistance shall equal that of B B″.

Thus suppose the distance (or l) of A A′=1 and their surface (S)=1 and their resistance (or r) consequently 1, and the quantity accumulated upon them before B B″ was added equals 1, then if the distance of B B″ equals ·5 and surface 1, its resistance will equal $\frac{\cdot 5}{1}$ or $r'=\cdot 5$ and a resistance having $l=1$ must have a surface equal to $\frac{1}{\cdot 5}=2$ or a surface double that of A A″. Thus the plates B C and B′ C′ would have a resistance between them equal to that between B and B″.

The total resistance of the inductive circuit after B B″ or C C′ are introduced will therefore be $\frac{1}{1+2}$ or $\frac{1}{3}$ and the quantity accumulated will, therefore, be three times greater than before the plates B B″ or C C′ were introduced. Now the quantity accumulated on equal resistances, whether of different lengths or surfaces, or not, under otherwise equal conditions, must evidently be equal. The quantity on B B″, must be the same

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therefore as that on C C′ and the total quantities accumulated in the two cases are equal. The quantity on A A′ is the same therefore in both cases, and the division of the total quantity accumulated in the two cases is the same; but it has been shown that in the case of C C′ and A A′ the division will be inversely as their resistance, and as the resistances of C C′ and A A′ are the same as those of B B″ and A A′, the division of the total quantity on B B″ and A A′ is also inversely as their resistance. In the same way it may be proved that in the case of any two resistances forming parallel or branch circuits, the sum of the quantities accumulated on them will be divided inversely as their resistance.

In the case above, therefore the quantity will be divided between the plates in the inverse ratio of their resistance or the quantity on the plates A A′ will be to that on B B″ or C C′ as 1 to 2; but the quantity generated when the branch B B″ or C C′ has been shown to be three times greater than when A A′ alone existed; calling this quantity on A A′, before B B″ is added, unity, the total quantity generated after B B″ is added, will be three; and this will be divided in the ratio of $\frac{1}{3}$ on A A′ and $\frac{2}{3}$ on B B″, or the quantity on A A′ is unaltered by the addition of the plates B B″.

*To generalize this law, suppose we have a branch circuit whose resistance or reduced lengths are r and r'. Then r will be equal to a resistance having a unit of length and surface equal to $\frac{1}{r}$, and r' will be equal to a resistance having a unit of length and surface equal to $\frac{1}{r}$, and the resistance of the two would be equal to a resistance having an unity of length and whose surface equal $\frac{1}{r}+\frac{1}{r'}$, or $\frac{r+r'}{r\,r'}$ or equal to a resistance having a surface equal to unity, and whose length equals $\frac{r\,r'}{r+r'}$ or the resistance of the circuit is equal to $\frac{r\,r'}{r+r'}$ or equal to a circuit of a surface equal to unity and length equal to the product of the two reduced lengths forming the branches of the circuit divided by their sum.

Let r = the resistance between two surfaces forming an inductive circuit.
„ r' = the resistance between two surfaces of a parallel branch added to r.
„ Q = quantity on one surface of r, before r' was added.
„ Q′ = total quantity on a surface of r and on surface of r'.
„ x = quantity on a surface of r, after r' is added.
„ z = quantity on a surface of r'.

Then the resistance of the whole circuit when the branch r' is added will be $\frac{r\,r'}{r+r}$

And, therefore, $\frac{r\,r'}{r+r} : r :: Q : Q'$

Or $Q'=\frac{r\,Q}{\left(\frac{r\,r'}{r+r'}\right)}=\frac{r\,Q\,(r+r')}{r\,r'}=\frac{Q\,(r+r')}{r'}$

And as the total quantity produced in the circuit, when r' is added, will divide itself inversely as their resistance, the quantity on a surface of r will be found by the proportion.

$$r+r' : \frac{Q\,(r+r')}{r} :: r : x.$$

Or $x=\frac{\left(\frac{Q\,(r+r')}{r}\right)r}{r+r'}=\frac{Q\,(r+r')}{r+r'}=Q$

Or the quantity on r is never altered by the addition of any parallel circuit.

And $z=Q'-Q$

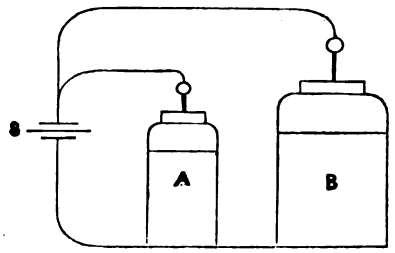
Thus if $r=10$, $r'=35$, $Q=20$

Then $Q'=\frac{20\times10\times45}{35}=\frac{900}{35}=25{\cdot}7$

$x=$ 20
$z=$ 5·7

When, therefore, an inductive circuit consists of only a single resistance, the addition of another one as a branch or parallel circuit cannot alter the accumulation on the surfaces of the primary circuit. Thus, if we have a Leyden jar, A, (fig. 52), having

Fig. 52.



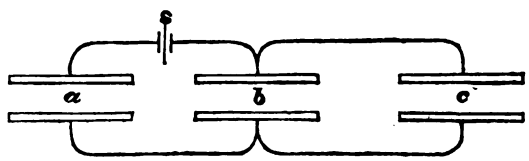
the inside coating attached to one side of a source S, whilst the outer coating of the jar is attached to the other side of the source; then the accumulation in the jar A will not be altered by the addition of the jar B, connected to the source in the same way as A, and the quantities in the two jars will be inversely as their inductive resistance. If therefore the jars are of equal thickness of glass, and that thickness bears a small ratio to the radius of the jars, the quantity accumulated in each will be directly as their surface. In the same way, when one pole of a battery is connected to the earth, whilst the other pole is connected to one end of a submerged telegraph cable, having its other end insulated, the charge will be unaltered in this cable, even if one end of another submerged cable, having its other end insulated, be also attached to the same battery pole; and the quantities in the two cables will be inversely as their inductive resistance. Supposing them of similar pattern the quantity will therefore be directly as their length.

By similar steps it can be shown that the addition of any number of parallel circuits will leave the accumulation in the primary circuit unaltered.

When there exists a resistance in the inductive circuit, which is common to both branches of the circuit, this indifference of one of the branches to the other no longer obtains, and an alteration in any one of the resistances affects all the others, but not all in the same degree.

Thus, if a, b, and c (fig. 53) be three resistances connected to

Fig. 53.



the source S, in the manner shown in the figure, then the alteration of any one of their resistances will cause an alteration in the accumulation on the surfaces of each of the others.

Thus, if a only be altered, the quantities on b and c will be altered, but will still retain the same ratio to one another. But if b be altered, c will no longer alter in the same ratio.

Let the resistances of the plates, a, b, c, be represented respectively by r, r', r''. Then the resistance of the whole circuit is expressed by $R=r+\frac{r'\,r''}{r'+r''}$

* The above paragraph, down to "divided by their sum," giving a brief *rationale* of the well-known equation $R=\frac{r\,r'}{r+r'}$ for branch conductive circuits is not original, but is nearly a translation from Blavier's excellent work.

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Let the quantity on each be respectively Q, q, p.

Then, since there must be always equal generation on each side of the source, Q must equal $q+p$, and as the quantity on r' and r'' must be inversely as their resistances,

$$\text{or } r'+r'' : r'' :: Q : p$$

$$\frac{r''\ Q}{r'+r''}=p \text{ and } Q-p=q$$

Let, now, the resistance of r be increased m times. Then the total resistance of the inductive circuit will be—

$$R'=m\ r+\frac{r'\ r''}{r'+r''}$$

The total quantity on each side of the source will now be found by the proportion

$$R' : R :: Q : Q'.$$

$$\text{or } Q'=\frac{R\ Q}{R'}$$

But Q′ equals the quantity on $b+c$, and this will be divided on b and c, inversely, as their resistance.

The quantity on b will be—

$$\frac{r''\ Q'}{r'+r''}=q', \text{ and on } c,\ Q'-q'=p$$

When R′ is greater than R, Q′ must be less than Q, but will always be divided inversely, as the resistances of b and c.

Or, in fact, if the common resistance alone is altered, an alteration on all the surfaces will take place, but the quantities on the surfaces of the two branch resistances will now bear the same ratio to one another as before.

(To be continued.)

PECLET'S CONDENSER.

This form of condenser consists of three discs, either of metal or of ground glass or slate, covered with metallic foil or leaf. The three discs are superposed, and the lower one is generally attached to a stem of a gold-leaf or other electrometer (see p. 279). This disc is varnished, on its upper surface only, with several layers of shellac. The middle disc is furnished with an insulating handle or stem of glass, varnished with shellac, and is covered with shellac on both sides, but not at the circumference. The upper disc, which is perforated at the centre, has also a handle made of glass tubing, through which passes the handle of a second plate; this disc is varnished on its lower surface only. In using the condenser a charge is communicated to the upper disc; the charging capacity of which is very high owing to the small amount of resistance to induction offered by the layers of varnish between the conducting material of this disc and of that immediately below it. Under the influence of induction, the upper surface of the latter acquires a charge of an opposite nature to that communicated to the first disc. This charge is rendered permanent by touching the circumference of the second disc with a conductor in communication with the earth, when the free electricity of the same nature as that of the original charge, is conducted from the second disc. The upper disc is now removed, and may be placed inverted upon its insulating handle. The second disc has now a free charge, and exerts an inductive action upon the lower disc, which, again is touched at its lower surface, with a conductor, such as the finger. When the second disc is now removed the free electricity of the lower disc becomes distributed upon the electrometer. The second disc may now be replaced, after having been discharged, and the *charged* upper disc superposed. By repeating the operations as before, a further charge may be communicated to the instrument. The main advantage of this form of condenser is that the charge which is ultimately induced is of the same nature as that of the source from which the electricity is communicated to the upper plate.

PRICES CURRENT OF INSULATING MATERIALS.

Gutta Percha.

The market is cleared of every description at very high prices, and the buyers are anxiously waiting the arrival of the small parcels now on the sea.

India Rubber.

Fine Para	2s. 2d. per lb.
Java	1s. 5d. to 1s. 6d. per lb.

Upwards of 25 tons of very low quality Negro Head has been sold to the home trade at 1s. 1d.

April 23, 1862. Wm. Kirkmann,

4, Honeford Buildings, Fenchurch Street, E.C.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do. B 7 per cent. till 1862	all	18 to 20	———
20	Do. C. „ „	all	9 to 11	———
10	Channel Islands Telegrap	all	———	———
Stock	Electric Telegraph	100	98 to 101	99¼
25	Do. New	15	— dis.	———
5	London District Telegraph	4½	3⅜ to 3½ dis.	———
10	Mediterranean Extension Tel.	all	3½ to 4½	———
10	Do. 8 per cent. pref.	all	———	———
20	Red Sea and India Telegraph	all	19¾ to 19½	19⅞
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	———
1	Do. registered	all	3/8 to 5/8	———
10	Do. „	all	4 to 6	———
2	Telegraph to India	1	⅛ dis. ⅛ pm.	———
5	United Kingdom Telegraph	2¾	1½ to 0½ dis.	———

Telegraphic News.

INDIAN TELEGRAPHS.

The Government of India has sanctioned the construction of a line of telegraph between Agra and Deesa; the expense of such portions of it as pass through Jeypoor, Ajmeer, and Meywar, being borne by the states benefitting by the same. This does not refer only to the expense of construction, but the permanent maintenance of the staff and material requisite to keep the line in working order. After the cost of construction has been defrayed, each state will be assessed at an annual rate, according to the importance to it of the line, or the benefits derivable therefrom.

PERSIAN TELEGRAPHS.

The telegraphic communication will shortly bring Teheran into direct communication with Western Europe. From Bagdad to Teheran the poles are nearly all posted, and the line only wants the placing of the wire to be complete. Another line, from Teheran to Khorassan, is to be immediately constructed; the engineers have already been sent off to make the necessary arrangements, thanks to Mirza Jaffar Khan, the late minister plenipotentiary to the Court of St. James's, with whom these schemes are said to have originated.

Recent Patents.

2003. J. Reeves, America, "*Electro-magnetic Engines for Obtaining and Applying Motive Power.*"—Dated 16th September, 1861.

This invention has for its object improvements in the combination and arrangement of the several parts of electro-magnetic engines, and these improvements apply, more particularly, to that arrangement of apparatus for which a patent was granted to the present patentee the 22nd day of February, 1861 (No. 449). The present improvements in electro-magnetic engines consists in supporting a slotted ring or wheel on studs projecting from the fixed plate which supports the apparatus; and on this slotted ring or wheel, holders are placed through which the wires from the galvanic battery and helices pass and are brought in contact with another ring or wheel formed of non-conducting material with spaces in the rim which hold conductors. This ring or wheel is attached to the driving wheel, and when in motion makes and breaks contact continually between the wires from the galvanic battery and the helices. The surface of the ring or wheel for making and breaking contact is prepared with sand, emery, or other suitable material, so as to cause friction, and thus rub and clean the ends of the wires as they pass over it from the "fuse" or "glaze" produced by the action of the electro current when in contact, by which arrangement a great obstacle is removed which has hitherto existed, and has prevented the full power of the battery from reaching the helices. A lever is employed to change the position of the slotted ring before mentioned, and with it the wires which pass to the wheel or ring which makes and breaks contact with the galvanic battery, and by this means the patentee regulates the speed and reverses the direction of the engine to produce a backward or forward motion as required.

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2310. R. A. Brooman, Fleet Street, London, "*Apparatuses for Stretching, Supporting, and Uniting Telegraph Wires.*" A Communication. Dated Sept. 16th, 1861.

The apparatuses now in use for stretching telegraph wires carry at each end a roller, upon which the ends of the two wires are wound; this roller being solid, the third wire is requisite to unite the two wires. By the means about to be described, a third wire may be dispensed with, and this part of the invention consists in forming the rollers with a slot extending to the axis, and in forming the axle of the rollers hollow from the point where the slot terminates. The ends of the wires are carried through the slots, and passing through the hollow axle are brought towards each other, and are united in and by a clamp, in which a wedge or wedges are inserted to jam the wires with a pressure screw for tightening up the wedges. The solid end of the rollers is provided with a ratchet wheel and ratchet, and with a square or angular spindle, which, on being turned with a key, stretches and tightens up the wires as required. This invention also consists in stretching telegraph wires by means of pincers made with grooved jaws for gripping the wires; behind the jaws is a bar for uniting the jaws while the legs of the pincers extend outwards from each other; the ends of the legs are united by two connecting rods, themselves connected by a pin at one end of the bar, the end of which terminates in an eye; a cord is fixed at the eye, and is carried round a windlass or barrel. By turning the barrel the legs of the pincers are pressed outwards, and the jaws are thereby tightened on the wire, and the strain being continued, the wire becomes stretched to the extent required. The apparatuses for supporting telegraph wires consist of a fixed upright and of a jaw hinged to it; the upright and jaw are formed with grooves in which the wires are placed and supported, and the two parts of the support are kept together by means of a screw.

2429. M. Theiler, Einsedeln, Switzerland, "*Telegraphs.*" Dated 28th September, 1861.

The first part of this invention relates to dial instruments in which the letters, figures, and other marks are presented on a dial as in other telegraphic instruments of this description. Both the sending and receiving station being in circuit, the hands of the dials at both stations move in uniformity. The peculiarity of these improvements consists in a far less number of currents and motions being required for carrying the hands round the dial than in any other instrument hitherto used. The second part of this invention consists in the combination of the dial telegraph with a mechanism for printing letters and other marks. The third part of the invention consists in improvements in the Morse and other mark-printing instruments, whereby the various marks representing the letters of the alphabet and other marks can be produced or printed with greater rapidity.

2425. J. Reeves, New York, "*Electro-magnetic Engines for obtaining and applying Motive Power.*" Dated 28th September, 1861.

This invention consists in constructing helices with copper or other metal cylinders, and placing them one, two, or more in number, as may be required, in line with each other, leaving a space between the ends, and through these helices the patentee passes a metallic piston, encircled with iron tubes placed at proper distances apart from each other, which, when acted upon by the electric current, are put in motion, and the piston is thus caused to pass through the helices from one end to the other of the series and back again to a greater extent than it is possible to obtain by the piston passing through one helix alone. The piston is connected by a rod to a crank on a driving axis to give motion thereto. The advantage obtained by this arrangement is that the length of the leverage or crank on the driving shaft of the machine can be varied to any extent desired, and the combined and successful action of a series of helices may be brought to bear thereon.

2395. A. V. Newton, Chancery Lane, London, "*Construction of and mode of working Telegraphic Apparatus.*" A Communication. Dated 25th September, 1861.

This invention relates to a novel arrangement of mechanism for transmitting currents of electricity, and termed by the inventor the "pantelegraph," which mechanism depends for its accurate operation on there being a perfect accord or synchronism between the oscillations of the pendulums of two connected instruments, placed at distant stations, the metallic circuit between the stations being made and broken, as is well understood, by the oscillations of such pendulums. The desired accord in the action of the pendulums it is now proposed to obtain by the pressure of a spring, regulated by a micrometric screw. The invention also relates to the employment of a special arrangement of the electric battery by means of which, after every interruption of the principal telegraphic current, a weak current in the contrary direction is produced in the line wire. And the invention also relates to an arrangement of mechanism specially applicable to the copying of telegrams in Morse or similar characters. By the application of this invention the following results may be produced, viz.:—Firstly, coloured letters or characters are obtainable upon white paper direct by the line current, without any local battery or relay, and from original writing in ordinary ink. Secondly, dispatches may be reproduced either of the same size as the originals, or reduced, the character of the original writing at the same time being retained. Thirdly, different messages may be simultaneously transmitted through a single line wire. Fourthly, telegrams written in Morse or similar characters may be reproduced by electro-chemical action. The invention cannot be described in detail without reference to the drawings.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

SUBMARINE TELEGRAPH COMPANY.

58, *Threadneedle Street, London, E. C.*
Secretary's Department.

Dear Sir.—Referring to the account in your paper of the 29th ult., of the interesting telegraphic *soirée*, given by Mr. Samuel Gurney, M.P., I regret to see that no mention is made either of the Submarine Telegraph Company or the British and Irish Magnetic Company, having in any way assisted on this important occasion. From this report the reader would infer that the entire correspondence to the Continent of Europe, and elsewhere, was carried on by another company alone; such, however, was so far from being the case that the *greatest* lengths of communication were those over the Submarine Telegraph Company's cables.

The London District Company led three wires into Mr. Gurney's house, one of which they retained themselves, placing one at the disposal of the British and Irish Magnetic Telegraph Company, and the other at that of the Submarine Telegraph Company, which latter kept up an animated intercourse during the whole of the evening with all the capitals of Europe, as well as with Malta and Alexandria, Sonning and Heligoland.

The British and Irish Magnetic Company worked direct to Dublin and Maynooth, keeping up a continuous correspondence for several hours.

The London District spoke to their several stations in London.

The Electric and International Company communicated with Falmouth, Edinburgh, Glasgow, and, late in the evening, also with Constantinople and Odessa.

I do not wish in any way to depreciate any services rendered on that occasion, and as little to obtrude those of this company, yet I cannot allow so one-sided a statement to pass uncorrected.

I, therefore, have to request that you will kindly insert these lines in your next number.—I am, dear sir, your obedient servant,

April 16th, 1862. L. Walter Courtenay, Secretary.

TELEGRAPHIC "LINE."

To the Editor of The Electrician.

Sir,—"L. L. S.'s" 6 cells of Smee. 4 inches by 6 inches, in a solution of sulphuric acid, 1 of acid to 10 of water will work the circuit he names. A weaker solution would be more economical, and perhaps as efficient, but much depends on the adjustment of his armature. Magnetos.

To the Editor of The Electrician.

Sir,—I hoped to have escaped a controversy on my essay, at any rate till the whole was complete, and, indeed, I was under the impression that the insertion of letters on the subject until the whole is published was contrary to the general rules adopted in such cases.

It is obvious that we may have time to write an essay on a subject, but *not* have time to re-explain and re-argue the whole matter to each individual who may hold other theories.

If, therefore, you should insert any further letters on the subject, I beg the readers of my essay not to construe my silence to an inability to answer the arguments or assertions that may be brought against me and the principles I set forth. As, however, you have already inserted two letters from "Au Revoir," which, if left unanswered are liable to mislead, I now reply, though not with any hope of convincing "Au Revoir" himself; for it is easy to perceive, from several of his letters, that he has a remarkable tendency towards the views set forth in your "Steps to Theory;" so much so, indeed, that were it not that those articles appear editorially I should be inclined to believe that he is their author.

With such a *penchant* towards such a theory there is not, therefore, much hopes of convincing him of the soundness of my views, which, as your readers must have perceived, are diametrically opposite to those set forth in "Steps to Theory." Still I may, perhaps, by answering "Au Revoir," make my own views more clear to others who may have the patience to follow me through my essay.

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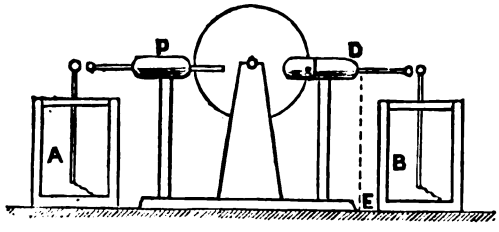
In answer to "Au Revoir's" first letter, therefore, the problem of halving the inductive resistance (page 197) was the result of theory, but *tested and proved by experiment*, so that "Au Revoir" will excuse me if, in spite of his kindness in telling me, in such a dictatorial tone, that my calculations are opposed to facts, I assert that they are in *strict accordance with facts.*

I don't think there are many electricians who have not long since known that the result of charging two jars simultaneously from opposite and insulated poles of a source, and then charging one such jar from one pole, whilst the other pole was connected to the outer armature, would produce the results described; it was only the explanation (viz., that the inductive resistance was in the one case exactly half what was in the other) that I considered novel, giving, as I am endeavouring to show in my essay, a more general rule for guidance in all such experiments.

The discussions which took place some time ago in the *Engineer*, on a subject closely allied to this problem, showed that there was a pretty general understanding on this point. As, however, an experiment directly bearing on the subject is not to be found in any book on electricity, I will detail one I have performed.

Let A, B, and C be three equal and similar Leyden jars. A and B were charged in the manner shown in fig. 36 (which figure, perhaps, you will be kind enough to reproduce.)

Fig. 36.



The knobs of the jars were only separated about one-eighth of an inch from their respective poles of the source.

The machine was kept in constant motion long after the sparks were reduced to a regular minimum, showing that the quantity generated at this stage was only the result of defective insulation. A was thus charged positively, and B negatively, with the greatest quantity they could, under these conditions, receive from the source. To prove that the two quantities were equal and opposite, the interiors of the two jars were put in conductive communication by means of a carefully insulated discharging rod, so as to allow their charges, which were of opposite nature, to neutralize one another if equal. On placing either of them, after this operation, in communication with a delicate gold leaf electroscope only the very faintest electrical signs were visible, showing that the two quantities of opposite electricity had completely neutralized one another.

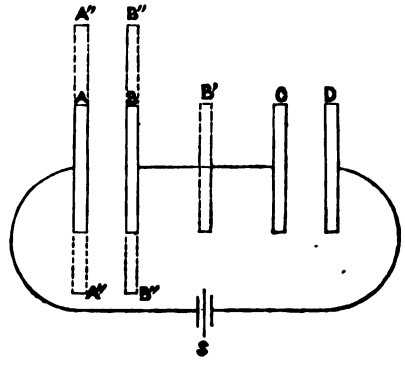
A was now positively charged from the prime conductor whilst the rubber was connected to its exterior by the communication D E. In doing this the machine was again kept in constant motion until in the same manner it was evident the jar was chargod to its maximum.

A now had its charge *divided* with the empty jar C, so that the quantity in A was divided between A and C, and thus the quantity in A *halved*. C was now discharged, and the connection D E being removed, B and C were charged from the two opposite poles, in the same way that A and B are represented in the figure; B positively and C negatively.

C was now put into communication with A, and the two opposite quantities thus allowed to re-combine. When either of these jars were now touched to the electroscope only the faintest negative sign was manifested, proving that *the quantity accumulated in one jar, when the two jars were in circuit, was exactly equal to half the quantities accumulated in the single jar circuit.* It is evident that as the jar A had to remain during the operation of charging B and C that its loss by defective insulation would account for the slight trace of excess of negative electricity. A was again charged alone with one pole connected to its exterior as before, and now left to stand with its *whole* charge. B and C were now charged as before, and C then put into communication with A. The positive quantity in A being now double that of C, the two jars, after being put in communication had a strong positive charge, giving a strong spark when discharged, and, of course, sending the leaves of the electroscope flying.

My theories show that this quantity left in each jar, A and C, should be one quarter the original charge of A; but this, for want of apparatus, I was unable to verify. The experiment could be much more accurately tried with a battery and three equal and similar lengths of submarine cable, as a voltaic battery forms a much nearer approximation to a simple constant source than a frictional machine, which is, after all, a compound machine. In the latter, the prime conductor and rubber themselves form surfaces which can become charged, by an indirect circuit to the surrounding objects; if, therefore, there is any great disproportion between their surfaces, they will more or less affect the result when the two jars are charged in the manner shown in the figure. For since equal quantities must be produced at each side of the source, the quantity produced at each pole will divide itself between the interior of the jar and the surface of the rubber or prime conductor, in the inverse ratio to the inductive resistance of the jar, and the inductive resistance separating the prime conductor or rubber from the surrounding surface.

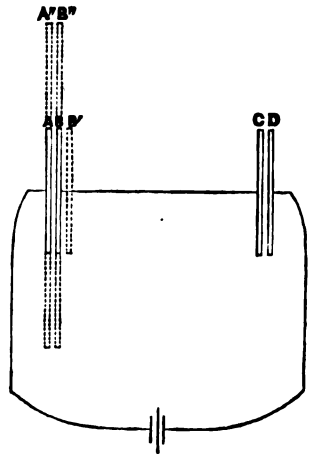
Now for "Au Revoir's" other objections. On pages 243, 244 I devoted a considerable space to showing that an inductive circuit composed solely of prismatic resistances was rigidly impossible, and that we could only approximate to it, but that we could assume such a state in order to investigate the general laws of an inductive circuit in its simplest form. It was pretty evident, therefore, that the figure 49 was given



simply as a diagram to facilitate the reasoning, and not at all to represent accurately the means of producing the *approximation* to an inductive circuit composed of prismatic resistance alluded to. It is rather hard, therefore, that "Au Revoir" should immediately commence treating it in the light of a fulfilment of such conditions as would give the *absolute* results shown in my calculations.

My previous reasoning on the subject, and particularly that given in reference to fig. 40, shows pretty clearly that I could never expect a practical and exact representation of fig. 49 to give anything approaching to the results detailed. I have shown how the inductive action, would go on from A and D to the surrounding objects, and it would also be evident between B extended to B'' and D an action would take place. It would also be evident that if the plates were separated the amount shown in the figure, in proportion to their size, these inductive actions would bear such a proportion to the quantity accumulated by the direct action between the plates, that nothing like the results calculated could be expected.

Let the accompanying figure represent the proportion of the plates, and



let them be supposed in the *centre of a large room*, and I *maintain* that the quantity accumulated on any other part than their proximate sides will bear such a small proportion to that accumulated on their proximate sides, that the inductive action may be said to take place "*practically between these surfaces,*" and the result would be, that if formula were applied, the calculated quantities would be very approximate to those observed or measured.

I did not intend, however, in the figure given even to suppose them in a room, but let them be supposed far above the earth, and as far apart as we please, in fact, as specified, so far removed from surrounding objects that the inductive action would take place practically between them.

I am quite aware from "Au Revoir's" letter that even under such conditions he will maintain that the outer parts of the plates A and D and the inner sides of B and C could become as much charged as ever in accordance with the "*charging capacity*" theory set forth in "Steps to Theory," and which "Au Revoir" so strongly recommends for my

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guidance, so that I am quite prepared to receive further contradictions, and your readers and time must decide which theory is most correct, for I maintain that if the plates, as represented, were in a boundless dielectric, the inductive action would take place *absolutely* between the two sets of plates as given in the formula, and that the only quantity which the plates A and D can in any case receive, beyond that due to the circuit as represented, is that which would be caused by the action that would take place between them and the common surrounding objects (or what I term the indirect circuit), and which action cannot in practice be entirely obviated, but only, according to circumstances, reduced to such a proportion, as regards the direct circuit, that it may be neglected, and thus the formula given applied with approximate accuracy. But I would impress upon your readers, that the problem was not given with the immediate view of its application to flat plates, but as an *a priori* form of considering the case of an inductive circuit formed of two consecutive resistances as a step to its application to those circuits composed of resistances of such form that the inductive action takes place almost absolutely, in that circuit, such as that composed of two Leyden jars or two submarine cables, in which case, I maintain, the forumla given will rigidly apply. All this is, however, I think, pretty well explained in No. 21 of your journal.

"Au Revoir," therefore, maintains that at starting the quantities on each plate are not equal, whereas I maintain that in an assumed boundless dielectric they are absolutely equal, and that we could so arrange the plates in practice to have practically equal charges on all; but I need scarcely repeat not in the proportions shown in the diagram 49, nor if plates of the size and form, and size of support, shown in your "Steps to Theory," fig. 26, which may be probably similar to those your correspondent "Au Revoir" has in mind when considering the question. "Au Revoir" next says, "Nor is it a fact that the accumulation on C and D is diminished by separating A and B further from one another, although the charge of the two latter is thereby made smaller."

Now, if the charge on the plate A is diminished whilst the charge on D remains the same, *unequal quantities must be generated at the two sides of the source*, for these plates are connected to the *opposite* poles of the source.

"Au Revoir" must hold, therefore, *that unequal generation from the two poles of a source* can occur, which is in exact opposition to my fundamental axiom on which I base my whole reasoning. And since he allows unequal generation it is evident that he must allow it to be unequal to any amount, and that accordingly we can charge a conductor from one pole only of a source when the other is insulated, and has no opposing inducing surface. I can hardly believe, however, that "Au Revoir" can hold such a theory, he has probably not seen that the plates A and D are connected to opposite poles; but in case he really holds such a theory let me observe that the commonest experiments teach us otherwise. If we attempt to charge a Leyden jar from the prime conductor, when the rubber is insulated, we may obtain a few sparks, but only from the fact that the rubber itself forms a surface separated from the surrounding surface by a certain inductive resistance, and thus an inductive circuit is formed which will allow of a very slight accumulation in the jar. Apply more rigid conditions and this even disappears.

Let "Au Revoir" try to charge a submarine cable from one pole of a battery, the other pole of which is insulated, and he will find that no charge can be obtained; in proof of this let me refer him to Professor Wheatstone's experiments on a submarine cable, detailed in the Government Report, page 291, experiment 2. "On bringing one end of the wire (an insulated submarine cable), "in contact with one of the poles of the battery, the other pole having no communication with the earth, the wire remained uncharged." Or let him try to charge a submarine cable (insulated at its distant end), from one pole of a battery, the other pole of which is connected to a well insulated line wire of the same size and length as the conductor of the cable, and he will find that the charge will be scarcely perceptible, as the inductive resistance separating the line wire from the earth is practically infinitely great, and this resistance forms one of the resistances of the inductive circuit, the other resistance being from the interior of the cable to its exterior surface.

"Au Revoir" next says that the extension of the two plates A and B to A″ B″ will not alter the induction between "*them*." (I scarcely know to which plates he alludes), but as this will alter the accumulation on both sets, I must again beg to differ from him.

Again, applying the case of submarine cables, Professor Wheatstone found that although when one pole of a battery was connected to a cable, the other pole remaining insulated, it could not become charged; yet that when two similar and equal cables were attached to the opposite poles, they both became charged equally and oppositely. Unfortunately, Professor Wheatstone did not try the experiment, whether the charge in one of them was half that obtained in one charged with the other pole to earth, which would have been an exact repetition, in another form, of the experiment I have detailed with Leyden jars, fig. 36.

Now these two experiments, simple—almost obvious—as they are, are in exact accordance with my formula; for suppose a short length, say one foot of cable was attached to one pole of a battery, and the same length to the other pole, then certain equal quantities of opposite electricity would, according to the experiment and formula, be generated in each, although that quantity would be exceedingly small, and quite inadequate to influence a galvanometer. Call that quantity 10, then although one of the cables be produced in length m times (or say a hundred miles), the total quantity on each side of the source could never reach to double the former quantity, or in fact to 20, and consequently would not be appreciable on a galvanometer, which is exactly what the galvanometer proved. If now the *small* piece of cable is also increased m times, the total resistance of the inductive circuit has been decreased m times, and the quantity generated on each side of the source is increased m times. If m equals 100 miles, the total quantity has been increased 608,000 times, which consequently constitutes a strong charge, as proved by the experiment in question.

"Au Revoir" may possibly dispute, or not see, the similarity between increasing the length of a submarine cable and increasing the surface of two plates opposed to one another; but I believe many of your readers will see the matter in its proper light.

The proof of the formula in intermediate cases, such as when the two lengths of cable are such as to have a measureable quantity at first, and then doubling or trebling one length, the other remaining constant, I am aware is unproved, but I have perfect confidence in its accuracy, and should be very glad if those who have lengths at their disposal would test it in an impartial spirit.

From what "Au Revoir" says, after contradicting my statements, viz., that "Mr. Webb is forgetting that A is in conductive communication with the source," it seems to me either that he does not see that the plates A and D are connected to opposite poles of the source, and consequently confounds the problem with the charging of two plates from the same side of a source (a problem which happens to form the next portion of my essay), or else this must be a further proof of his belief in *unequal generation*.

It may appear to your readers that I do not support my views sufficiently by direct experiment. I am aware of the general value set on anything resembling an experiment, but I believe this is often carried to extremes, and the most ordinary or old experiment put in a different form with a *new interpretation*, is liable to lead many at once to accept the interpretation, merely because it seems to be supported by *direct experiment*, without thinking for themselves as to the value of the interpretation, and how far they agree with general results. I am certainly open to the accusation that I am making a new interpretation, and yet adduce *no experiment at all*, but your readers must not suppose that I do not constantly check my steps by perpetual reference to the hundreds and hundreds of experiments which are already published. I would willingly put them to fresh tests, but as they often refer to definite proportions, they require instruments of accurate measurement, and other means not in my possession.

The interpretation I am thus advancing, which may be said to consist of so analysing inductive action as to bring it within reach of Ohm's law, will, I feel confident, prove of more practical value than at first appears. I am encouraged to believe the path a correct one by the experiments of Mr. Gaugain,* who I find has simply applied Ohm's law to the case of inductive circuits composed of a *single resistance* in the shape of flat plates, concentric cylinders, excentric cylinders, and concentric spheres, and tested the result by a series of careful experiments with perfect success. I was not aware of them until just after my treatment of spherical conductors. My reasoning, your readers will perceive, has been based on the single equation $R = \frac{l}{s}$, combined with the *fundamental axiom of equal generation at the two poles*, and on them I have advanced, not to merely circuits composed of one resistance, but to circuits composed of two, and then to branch circuits, &c.

The complete way in which this mode of dealing with the question allows us to determine the effect of altering an inductive resistance when once the inductive circuit is a defined circuit, will, I feel confident, be allowed when I have finished. All I request is, that my readers will not throw my labours on one side as incorrect on the first contradiction of their accuracy from an anonymous writer.

"Au Revoir" refers me, for general light on the subject of electrical accumulation, to study "*the cause of charging capacity*," by which I infer he would refer me to the views on "*charging capacity*" given in "Steps to Theory," for that is the only work in which I have ever seen the term "charging capacity;" but if so, I can only say that I have carefully read the article in question, and if the paragraph (91) may be considered as the law which the charging capacities of conductors are supposed to follow, I am bound to say that it is quite contrary to my views, and also to all the formulæ for inductive resistance which have been tested experimentally. I here quote the paragraph: "91. And as we have already demonstrated (80, *et seq.*), that charged surfaces freely surrounded by the air, have, under equal intensities of electrical induction, inductive atmospheres that extend to equal distances; it follows that under any given intensity of action they will have relative charging capacities that vary in a simple ratio with the surfaces of their enveloping atmospheres, all measured at one particular distance. It was thus that we proved that the little middle ball in figures 7 and 8 had a considerable charging capacity in one of the cases there shown and none in the other; and also that in fig. 6 the capacity of the larger sphere, *b*, was more considerable than that of its smaller associate, *a*."

* See *Philosophical Magazine* for March.

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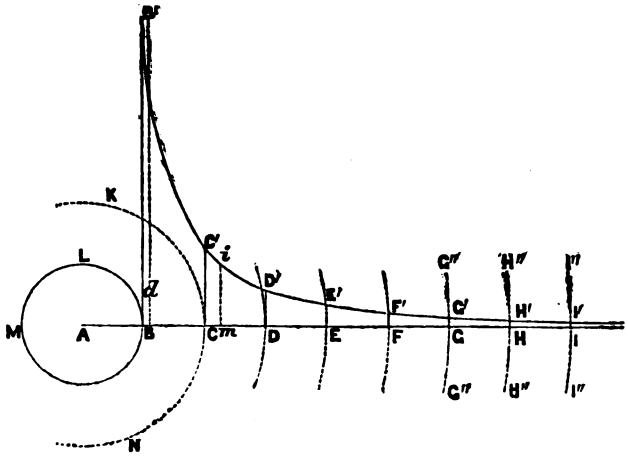
From this, therefore, a conductor of given size and form must have a given capacity for charge, from a given source, as long as it is freely *surrounded by the air;* this appears to me to be rather vague. What distance off from the given conductor may the surrounding objects be in order to fulfil the conditions of its being "*freely surrounded by the air.*" Must it be in a boundless dielectric? If so, I maintain it could receive no charge at all; or may the surrounding surfaces exist at a *certain* distance from the given conductor without affecting its charging capacity.

Now I maintain, as your readers must have seen, that the given conductor would have a capacity for charge, from a given source, which would be *entirely dependent on the position of the surrounding surfaces*, and the conductors intermediate between that surface and the given conductor. The influence of the distance of the surrounding surface in the case of a sphere, and the law which it follows, has been, as I have observed, carefully tested experimentally by Mr. Gaugain. And in the case of cylinders (in the form of submarine cables), by many, and the formulæ, such as those I have given, found perfectly correct. It is impossible to reconcile these facts with the idea that a conductor of given form has of itself a definite charging capacity.

The quantity accumulated on a given conductor attached to a given source depends on the position of the surrounding surfaces, and diminishes as the two surfaces are more distant in the case of spheres in the inverse ratio to the portion of the space comprised between the curve B′, C′, D′, &c., and the line B H, cut off between B (the surface of the



inner sphere), and C, H, I (the surfaces of the different outer spheres). It will be seen that after the outer sphere exceeds that of the smaller one by 6 or 7 diameters, the increase of resistance obtained by a further increase of one diameter, is very small compared to the resistance already existing.

In practice, as I pointed out, inductive resistance after a few diameters increases very slowly with any increase of diameter of the outer surface, but this is no reason that it does not increase theoretically just in the same ratio as before, instead of vanishing at a particular distance from the surface of a conductor, to which distance the term *inductive atmosphere* is applied in "Steps to Theory."

Mr. Gaugain gives the formula for proportionate intensity of charge with a given source for different spheres.

$$I = \frac{R\,r}{R - r},$$

where r equals radius of inner sphere, R that of outer.

And Mr. Longridge's calculation of the proportionate inductive resistance is

$$R = \frac{D - d}{D\,d},$$

where D is the diameter of the outer sphere, and d that of the inner Both of these agree with my geometrical problem.

I cannot, therefore, say that I see much hope of my becoming a convert to the theory so strongly recommended by "Au Revoir;" but I am much obliged to him for the advice, and in return would recommend him to study a few cases of accumulation when both poles of the source are insulated, and the surfaces of the conductors attached to each pole greatly disproportioned; also to consider a few of the facts relating to the charging and discharging of submarine cables, also to consider the case when a single conductor is charged in the usual manner, of approaching the surrounding objects to it, and lastly, to perform a few experiments on inductive circuits composed of two *successive* resistances, and then testing the effect which the alteration of one such resistance will have on the total accumulation, &c., as given in my last number. It seems to me that "Au Revoir" is one of those who have studied electricity principally from experiments on frictional machines in a room, and is unacquainted with the mine of facts connected with accumulation which have been opened out by submarine telegraphy.

In conclusion, I must once for all state that it is impossible for me to answer any more letters on the subject of my essay until the whole is complete, when I shall be happy to give any explanation that may be required; but, in the meantime, it is evident that I could not afford the time to answer, as I should wish, any objections which may be raised against my calculations, even if you, Sir, could afford the space.

F. C. Webb.

SUBMARINE TELEGRAPHY.

To the Editor of The Electrician.

Sir,—That the above subject is one of the important topics of the day cannot for a moment be doubted; that it is a difficult one rightly to solve, would appear from the varied views taken by electricians and others, and when we consider the amount of science and experience which electricians and engineers have brought to bear upon this subject, it leads one to enquire how it is that long lines have hitherto been so unsuccessful.

The answer to this question is, I think, supplied by the very principle which men of science have laid down as the basis of their operations; namely, the principle of force. They seem to have taken for granted that the work they had to accomplish was one of violence, that force and distance were corelative terms, and that as the latter was greater the former must be increased in direct proportion, hence the amount of battery power employed, which by its construction increases the difficulty of the electric passage, adding induction to the various impediments arising from causes such as earth currents, &c., and the effect has been a rupture of the insulator, and a dead stop sooner or later.

From my long experience in the use of electricity, I have endeavoured to act upon an opposite principle, and have dealt with this subtle and most delicate element—electricity—in an humble, and, I feel, more congenial way. In the existing system I conceive the following to be some of the principal objections.

1st. The battery power necessary to overcome the various resistances, is such as must sooner or later destroy the insulation of any cable.

2nd. The retardation of the passage of the electric current along the wire is greater or less according to its purity and its sectional area; the purer the quality and the greater the area the freer is the passage, but as the wire is purer in quality and greater in area in the same degree, its cost increases, and so does its weight. This, especially in the latter respect, constitutes an objection of great importance.

3rd. Induction is another cause of retardation; this arises from an interaction between the wire and its insulating covering, or dielectric, producing in the latter an opposite polarity. If the sectional area of the wire is increased, and the thickness of the dielectric diminished, the amount of induction is proportionally less. But then the weight of the wire, besides the objections stated above, it has this further disadvantage, namely, that it tends to make it knuckle through the insulator whenever it is bent, as in coiling for instance, and moreover, to make it sink, by gravitation, from its central position, whenever the insulator, whether it be of gutta percha or of india rubber, becomes softened by heat. This has been found to be a formidable objection to cables in the hold of a vessel, even in those cases where the conductor was of a light formation.

4th. A counter current, called earth currents, produced by the natural and unavoidable flow of the earth's electricity into the cable, from the earth plate at the distant end of it, and charging it in the opposite direction, is an additional difficulty, and perhaps one of the greatest that militates against the present system.

Now the advantage of my system consists in this, that I have, I believe, overcome all the objections before enumerated, by the fact that my cable is constantly in a static electric condition, and merely requires that the state of equilibrium be disturbed in order to produce the desired signals. By what I have before stated you will perceive that I have succeeded in "enticing," as it were, the electric fluid, and not to "force" it, and that by my system the old enemy—the ocean—I convert into a friend and make use of it, and as perfect insulation is unimportant, my cable being at all times (as I before observed), statically charged. I only require its state of repose to be disturbed at either extremity; the whole line feels its impulse, and is alive from end to end; and my opinion is that there is *no current whatever*, but one instantaneous sensation.

As to the mechanical and financial objections to the weight of the cable and the cost of the wire, this is satisfied by the fact that according to my system the cable may be made of any specific gravity required, and the size of the communicating wire is unimportant.

In conclusion, sir, I may observe that my system is incomparably less costly than the existing one.—I am, sir, yours, &c.,

16, *Argyll Street, W., April* 15, 1862. W. P. Piggott.

THE JOINTS OF GUTTA PERCHA CORES.

To the Editor of The Electrician.

Sir,—Having read the admirable and useful "Random Papers by a Practical Man," upon the various methods adopted for making joints in gutta percha and india rubber, I cannot help thinking but that a reprint of the papers in a book form would be of great service to the art of telegraphy. One day, in proceeding along one of the City thoroughfares, I stood to witness the operation of jointing subterranean gutta-percha-

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covered wires. The precautions insisted upon by your "Practical Man" were certainly not observed. There were no clean hands, and as each thin lapping of gutta percha was being put on, the large quantity of dust flying about which adhering to the surface of the slips of gutta percha, must form a ready path for the current to escape. No wonder our subterranean wires so often fail! A Rambling Electrician.

To the Editor of The Electrician.

Sir,—Can frictional electricity be generated in vacuo? If it has not been tried, perhaps some of your correspondents have the means of doing so. If any would take the trouble, and publish the result, myself and friends would feel obliged, Catos.

THE INDUCTION COIL.

To the Editor of The Electrician.

Sir,—I have constructed a condenser as advised by you, and attached it on the usual principle, but it certainly does not increase the power, as the one I had first. A word or two on the condenser would be deemed a favour. I have taken the liberty of sending you two sketches of the condenser; will you be kind enough to say which one is made on the right principle: the dark lines, B, represent the tin foil, and the light lines, A, the varnished paper. In fig. 1, the ends are all collected together, and each portion, C and D, are united to the separate portions of the contact breaker. In figure 2, the first and last sheet of tin foil are attached to contact breaker the same way, will you be kind enough to say which is correct, No. 1 or No. 2. The one I have constructed is on the No. 1 principle. —Yours truly, J. Cook.

P.S. Since writing the above, I think I have discovered why the condenser does not act; but I am still more puzzled to find that on *making contact* with the primary wires, that neither is a shock felt, or the slightest symptom of spark or current in the secondary wire, but on *breaking contact* a very powerful shock and spark is the result, the bundle of iron wires become powerfully magnetic, so I cannot conceive why there should not be a current in the secondary wire. I reason from this, that this is the cause of the condenser not increasing the power, I imagine the condenser becomes charged when the contact is broken, and discharged when contact is made, but no electricity appears in the condenser; in fact, it seems to *decrease* the power of the secondary current. The primary wire is composed of three layers of No. 14 copper wire; length of iron core, about ten inches; secondary wire, fifteen layers of No. 36 copper wire well insulated with shellac, the last layer of secondary being distant from the last layer of primary about ¾ inch, or less. If I am not trespassing on your time too much, I should be glad if you can give me any reason for this. In speaking of the condenser, would not copper foil be better for its construction, being a better conductor, and somewhat cheaper than tin foil? I forgot to mention that the battery power is one of Bunsen's small size.

[The condenser you have made is the right one. You do not state how many sheets of tin foil are used in it; but it is evidently unnecessarily large when employed with such small battery power. Poggendorff says: —"With a condenser of one square inch only, sparks may be obtained as long as when a large condenser of oiled silk is used!" but he adds:— "Large condensers appear to give a greater effect when two couples are used instead of one, and it is probable that their action would be much more efficacious if considerable battery power were used." Poggendorff appears to have been very careful of injuring his instruments by employing too strong a current, and he did not, therefore, verify his opinion, which, however, has been found to be quite correct. A large condenser is required when the primary circuit is composed of a considerable length of fine wire, or when tension is added to quantity in the current. The effect, or absence of effect, you notice on making contact with the battery, affords an interesting problem involving many important points in electrical science. We can only briefly suggest an explanation. The intensity of the effects observed in the induction coil are mainly due to the *rapid* magnetisation and demagnetisation of the coil of soft iron. Now, a conducting wire is known to receive a certain amount of static charge before the electricity freely passes through it in a dynamic form; that is, as a current. The quantity of electricity accumulated as a charge in a conductor varies according to the "charging capacity" of the latter, which depends upon the facilities which are afforded for electrical induction. The condenser attached in the primary circuit of the coil is virtually a portion of the primary conductor; the capacity of which for static charge becomes thereby greatly augmented. When contact is made with the battery, the wire acquires a certain charge, and the condenser a charge of comparatively great amount; and until the full amount of charge is given, the full force of the current does not become manifested in the wire. Under these circumstances the soft iron core becomes but slowly magnetized; and the effects on *making* contact are thereby decreased. We were not aware that copper foil is cheaper than tin foil; the former would answer as well for the condenser, but the superior conductivity of the metal does not influence the result.—Ed. E.]

To the Editor of The Electrician.

Sir,—From the careful perusal of your most instructive "Steps to Theory," I arrive at the conclusion, which was never quite clear to me before, that the *intensity* of the static charge in any system of conductors connected together is everywhere the same. Thus if I connect together a Leyden jar and several insulated conductors of different shapes, and charge the arrangement, the same intensity will, if I am right in my conclusion, prevail everywhere the charge extends; although the *amount* of charge, dependent upon charging capacity, may vary at different points. I must confess, however, that I am somewhat puzzled by such paragraphs, as the following, extracted from the last edition of "Noad's Electricity," p. 60:—"But though electricity may be considered as confined to the surfaces of bodies, its intensity is not on every part the same. On a sphere, of course, the symmetry of the figure renders the uniform distribution of electricity upon it inevitable: but if it be an oblong spheroid, the intensity becomes very great at the poles, but feeble at the equator." Now, does the expression intensity here signify the "amount of charge" or "quantity of electricity," or is it assumed that the *intensity* varies with the quantity? "Intensity," I take it, is equivalent to tension; but here it is obviously employed either in a different sense, or on the assumption I have pointed out. It appears that with electricity of a certain intensity, we can communicate higher charges than with electricity of a lesser intensity. Is the converse also the case, that by increasing the amount of charge we can increase the intensity? I fancy from my own experiments that this must be the case, but only under certain circumstances, which I cannot determine.

The intensity of the electricity from different machines in my possession appears to me to vary; that of the electricity from an excited ebonite plate being greater than that of the electricity from glass. Can this be the case, or does the intensity depend upon the amount of charge accumulated upon the prime conductor?

I read and re-read par. 57 *et seq.* of the "Steps." This I fancy must be the "leading conception" of the theory we are arriving at, and the key to most of the experiments which follow.

Your evident desire to set the electrical student right upon such points as the above, precludes the necessity of any apology on my part for thus troubling you.—I am, sir, yours obediently, Amateur.

[Our correspondent is right in his conclusion, all charged conductors, whatsoever they be, and all the parts of every one of them, if in communication, have one common intensity. This is now taught for the first time by our theory, but physical equilibrium has always demanded it. Facts have been supposed to proclaim otherwise, but the facts themselves have not been fully understood. We refer "Amateur" to paragraph 92, in which we promised the explanation of all this; when we have got on a little further the subject will be before us in its proper order. In the mean time we will suggest a consideration:—No one ever found unequal intensities indicated by two electrometers connected with the most diverse parts of any charged conducting system.

With respect to the quotation from "Noad," the expression intensity is there used, as in electrical works generally, to express measure of action, and not quantity of charge; it is now commonly admitted that intensity varies as the squares of the charges.

The intensity of the electricity furnished by machines varies with the nature of the dissimilar contacts, and also with the length of insulation; but this is anticipating our demonstrations.

When we have a charged conductor of any kind we can communicate equal intensities to all the parts of anything conducting put into contact with it, and in the resulting intensity it will itself participate; but the quantities of charge thus distributed may be very unequal, depending upon the relative charging capacities.—Ed. E.]

THE ATLANTIC TELEGRAPH.

To the Editor of The Electrician.

Sir,—Your vigorous efforts to promote the extension of submarine telegraphy deserves success. You have afforded us commercial men the means of judging for ourselves of the past, the present, and future of telegraphy. It strikes me, and that very forcibly too, that in the present state of the money market something might be done towards the great work of uniting England and America, and more especially so when the public views with favour investments in telegraphy. We have in a short time started three telegraphic companies, and whose shares are now at a premium. We also daily witness the formation of numerous companies for various other purposes.

Why should an Atlantic Telegraph Company despair of support? Let a company, either the old or a new one, at once enter the field of action. Let the shares be of moderate amount, say £10 each. I doubt not the result.—Yours, &c. Mercator.

Mincing Lane, April 22nd.

TUNNEL TELEGRAPHS.

To the Editor of The Electrician.

Sir,—On reading the Electrician of the 18th instant I was much surprised to find nothing said about the letter signed "Crumlin," which

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appeared in the Electrician the week previous; I can only account for the silence of your able correspondents by supposing that they think it is altogether unworthy of notice.

What "Crumlin" says about "rusty vanes on church spires" is doubtless a very accurate description of his own views upon the subject. I certainly felt rather shocked at his want of "faith," and as his opinion is given in such decisive language upon a subject about which he appears to have no practical knowledge, it is useless for me to tell you how erroneous are his assertions. I have shown the letter to several engine-drivers, but I will not shock "Crumlin" by repeating the expressions made use of; but I can assure you that they were not very creditable to the writer of that letter, and next time he travels on any line of railway where there is a tunnel I would advise him to secure a place on the engine or put his head out of the carriage window and observe to what distance the end of the tunnel is visible, and if a train should pass on the opposite line of rails note how many seconds the receding red lamps are visible. Why, a viaduct is about the safest portion of a railway, for there there is always a clear view in advance, and in cuttings, or tubular bridges, there is sufficient light to distinguish a signal at a considerable distance, but in a tunnel the signal is not visible for more than a few yards.

I admit that I ought to have used the word "suggest," instead of "patent," for I believe the patents are now out. Mr. Edwin Clark's system is, I believe, an excellent one, but it is "not a plan to guard a tunnel," or a short part of the line, what are its advantages, for on many railways it is impossible to allow a greater distance between the trains than two or three miles.

In your last paper there is a letter signed "T. C. J." which I have read over several times, but I cannot for the life of me make out what he writes about. I can understand that he is finding fault with me, but for what, or what it is he wishes to communicate I cannot understand. He entirely ignores what I said about Tyer's instrument, neither does he appear to understand that I recommended Bright's bells to be worked with the current direct, and not with the relay. I trust "T. C. J." will excuse my inquisitiveness if I ask him to be a little more explicit, for I really do not understand his description of blocking the needle. How can A block the needle to "*train on line*," when B has the same needle blocked to "*line clear?*"

"T. C. J." says "Bells which require no winding up can be employed," are such bells employed at an tunnel or signal station?

The train signal recommended by some of your correspondents requires three line wires, and if I rightly understand the manner of signalling the trains, whenever there is any interruption to the communication on any one of the three wires, the system is defective; and in my humble opinion it will be decidedly more dangerous than no telegraph at all. Tyer's instrument require but one line wire, and if that be broken, there is no communication whatever between the two distant stations, and the men at once commence to allow the trains an interval of time, and the caution signal, instead of an interval of space; and this I consider to be far preferable to an imperfect communication.

With due deference to Mr. Newman's remarks about the signals being indicated by either the top or the bottom part of the needle, I think it would be advantageous to cut off either the top or bottom part. I quite agree with him that "alarums should not be required to give intelligible signals, but be used simply to call attention to the needle instrument;" but bells may be required to give intelligible signals, and to answer both the purpose of an alarum and the needle instruments.

I am inclined to doubt that six years' trial on any line is a good proof of the efficiency of any system; I beg to remind you that the Clayton tunnel system had worked satisfactorily for nine years before it was found deficient.

I am glad to see the railway signal instruments receive so much attention in the Electrician of last week, which I believe will be duly anpreciated by those interested in railway telegraphs. If such an elaborate description of Bright's bell had appeared in the Electrician previous to my last communication, it would have greatly assisted me when attempting to describe the instrument I wished to suggest for tunnel purposes.—I am, sir, your humble servant, Inquisitive.

April 21st, 1862.

To the Editor of The Electrician.

Sir,—Thank you for your answers in the last number. The axis of the magnetic needle stands as nearly in the meridian as we can place it to make the indicating needle face north, and then it hangs over to the east, and when the indicating needle or axis of the magnetic needle faces to the south, the indicating needle then rights itself and hangs vertical. Can you account for this? In your next.—Yours truly, L. L. S.

[The magnetic north lays 22° west of the true north, or two points of the mariner's compass. If the axis of the needle is placed in the direction of the *magnetic* meridian, we cannot account for the effect you observe. If, on the other hand, the axis points to the true north when the deflection is observed, we should conclude that there is some defect in the pivotting, a by no means unusual occurrence. When the instrument is facing the true north, the needle would be deflected towards the magnetic north, supposing it to be perfectly pivotted; but the deflection is then increased by the imperfect, pivotting whlie the opposite deflection, when the instrument is facing the true south, is corrected by the same cause.—Ed. E.]

Miscellanea.

Trial of an Electrical Target.—On the afternoon of the 16th inst. Mr. F. N. Gisbourne's patent electric target was tested at the butts of the South Middlesex Rifles, Beaufort House, Walham Green, in the presence of a large number of gentlemen connected with the rifle corps of the district. The firing commenced at 150 yards, and was continued at 200 yards, with great accuracy, and the shots were correctly registered on the paper by the electrical machine of Mr. Gisbourne. The arrangement is simple, and from its simplicity arises its great accuracy and consequent value. The target is 6 feet by 2 feet, divided into 17 compartments—viz., a bull's eye, four centres, three above the centre, three below the centre, three tops, and three bottoms. These are connected by separate wires to the machine, and each compartment being a separate plate, it registers itself in the machine at the shooting stand. During the firing a circumstance occurred twice which seemed to impugn the accuracy of the apparatus. On one occasion it indicated wrong, but upon examination it appeared that the paper had been put into the machine the top side to the bottom, thus reversing the indication; but when it came to be compared with a paper properly inserted, it was found that the machine had done its duty accurately. On the other occasion the indication could not be found at all, but upon turning the paper over it was discovered that the machine had indicated the shot on that side, thus showing that the paper had been put in upside down. It is needless to say that the indication was correct. We were informed that the apparatus is capable of still further improvement and simplification; but, even as it stands, it will be found a valuable acquisition to all butts, particularly those at long ranges, and the expense of fitting them being a mere trifle, in comparison with their utility, there can be little doubt but that they will soon come into general use.

Electrical Apparatus at the Exhibition.—Collections of apparatus, specimens, &c., will be exhibited by most of the telegraph companies, amongst which will be seen the double-bell telegraph of Sir Charles and Mr. E. Bright, Professor Wheatstone's telegraph instrument for domestic use, Henley's magnetic telegraph, &c. The Messrs. Bright also exhibit their patented rarified-air lightning protector and their transmitting relay. The British and Irish Company exhibit three clocks, controlled and regulated by electrical agency, under the patented system of Mr. L. Jones of Chester. Messrs. Elliot have sent a large electrical machine with ebonite disc, and several delicate electrometers. Messrs. Murray and Heath will show an electric lamp in which the carbon electrodes are kept at constant distances without the intervention of any clockwork mechanism.

The four cables laid between Orfoidness and Holland were the first ever tested under water, when completed before leaving the manufacturer's yard. A dock was constructed for the purpose, outside Messrs. Newall's works at Sunderland, in which the cables were coiled as they left the covering machines. These cables were manufactured in 1852–3.

To Correspondents.

One anxious to Learn.—We agree with your remarks; but we cannot *at the present moment* carry your suggestion into effect. It is a higher and a more useful task to write for the millions than for the few only, and one which *should* necessitate at least equal attainments and qualifications. We should be sorry to think that any of the future great, who some day may claim one of Nature's patents of nobility, the title of electrician or chemist, should now, when toiling in obscurity, be debarred from reading our pages. But you must remember that the proprietary and the editorial are different, and may have different views.

T. Prideaux.—The prospects of deep sea telegraphy are by no means *disheartening*. The failures we confess have been very great; but they might have been avoided, had the "right men been in the right place." No one who carefully reads the evidence adduced before the late Committee of the Board of Trade can arrive at any other conclusion.

C. M. P.—Testing *in vacuo* and under hydraulic pressure.—The Government Report *does not* recommend the process, nor do any of the engineers and scientific men examined before the Government Committee approve thereof. We are well aware that the Malta and Alexandria cable was subjected to the test, but we are informed that not in a single instance was a "fault" discovered which had not already been detected by the more simple and efficient electrical test in the canal or water tank. It is ascertained that a sound core is not affected by any pressure it may be subjected to, and it has also been conclusively proved that no fault can pass the stringent electrical test which scientific experience has now placed at our command.

*** In "Crumlin" letter, page 276, line 33, for "persevering" read "penmen."

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The Electrician.

VOL. I. No. 26.—MAY 2, 1862.

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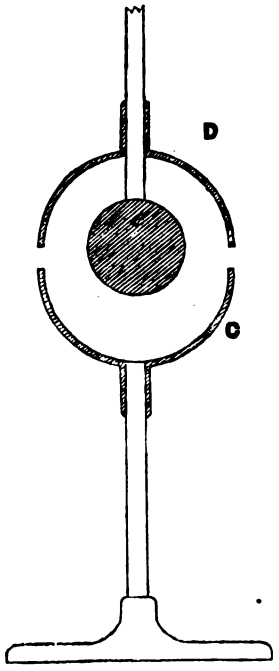
STEPS TO THEORY BY THE PRACTICE OF ELECTRICITY.

[Continued from p. 290.]

180. IT now has to be proved that static electrical induction sometimes occurs when it cannot be attributed to any conceivable action of contiguous particles of matter on one another; and to be shown that in such cases it can be satisfactorily explained in perfect consistency with all the other doctrines of our theory, by projecting *electrical attraction across sensible distances* whenever common matter does not intervene under circumstances that admit of its interference.

Fig. 27.



181. Prepare the apparatus represented in the above figure; C D are two hollow metallic hemispheres, susceptible of being put together by their edges, so as to form a spherical conductor smooth both on the inside and the outside, and about three inches in diameter; each of the hemispheres is insulated by varnished glass; the insulator of D being a tube passing through a ferrule above its centre into a brass ball *e*, one inch and a half in diameter, cemented to it in such a position as to be concentric with the hemispheres when put together to form for it an outer casing. The insulator of the lower hemisphere is a cane fixed at its upper extremity into an external socket, and at its lower end into a foot, on which the whole apparatus may be supported.

182. We know what would take place if, after putting a plus electrical charge upon the ball *e*, we were to place the hemispheres together while holding them so as to uninsulate them; the charge would act by induction outwards on the successive spherical shells of air between it and the outer case, and finally on the case itself, and the conducting matter of that case would discharge into the earth an induced charge in quantity the same as that of the central charge, and sufficient to exert an intensity of action precisely equal to that which would be sustained by a whole spherical surface of aërial particles supposed to be located at the same particular distance; but this is not the case we have at present to consider, we have to trace the inductive action in the opposite direction, that is to say, from without inwards. For that purpose let us first have the fact itself.

Exp. 28. Having put the two hemispheres together, pass a small brass wire down through the insulating tube of the upper one until it rests upon the bottom of the hole in the enclosed brass ball, the wire being long enough to project outwardly beyond the glass. Touching the external extremity of the wire with one hand, communicate to the insulated hemispheres with the other a plus electrical charge; and then, the hemispheres being still insulated, withdraw the wire from the tube. The upper hemisphere may now be lifted by its insulating handle from its fellow, and by means of the electrometer, its electrical condition as well as that of the inclosed ball examined one after the other; the hemisphere itself will indicate its possession of a plus charge which has been communicated to it, and the ball will be found to have a minus charge, having parted with electricity under the inductive action of the surrounding plus charge.

183. This experiment proves, first, that induction can take place from without inwards; in which direction the conditions of efficiency would be absent if induction depended upon diverging, or even parallel, lines of contiguous particles abutting against a charged surface; and, secondly, it proves that the internal surface of a hollow conductor is susceptible of charge, as well as its external surface, because it is the nature of attraction to bring things together, and the plus electricity acting upon the minus common matter of the ball would not have been at the shortest possible distance from it had it not passed from the outer to the inner surfaces of the hemispheres.

184. Now the theory of this case is not to be comprehended by applying to it solely the doctrine of the propagation of induction by contiguity of particles. Faraday would say with respect to it—"If the conductors are hollow and contain air, still no charge can appear upon that internal surface, because the air there cannot assume the polarized state throughout in consequence of the opposing actions in different directions." We say of it, in the first place, that it is a geometrical truth that the inner surface of a sphere can send off from all parts of it only such rays as converge; and secondly, that it is an electrical truth that if there were such converging rays of inductive action attempting to set out with a given amount of intensity, they would be stopped instantly by having to overcome a resistance whose intensity from the first moment would be greater than their own, and would increase rapidly at every step.

185. To make the result of the experiment intelligible, we need to regard electrical attraction as partaking so far of the nature of the force of gravitation as to be capable of acting across space *irrespective of its being empty or occupied with matter;* and adopting this conviction, then we become called upon to consider the plus electrical charge that we place upon the hemispheres of our apparatus, as having a choice of directions in which to throw out its inductive action; for on one side it has aërial particles progressively increasing in number, and capable of receiving the inductive action from one another under intensities of reaction perpetually and rapidly on the decline, until it becomes insensible, and therefore to us lost, or as we say, until an artificial equilibrium be established; and on the other side, it has at some comparatively great distance a conductor that is in communication with the earth, or it might be with some other large body, capable of receiving from it whatever electricity may be dismissed by induction, and disposing of it under a reaction that, practically speaking, is infinitely small.

186. In which of the two directions, therefore, will the charge thus circumstanced set up inductive action? The answer obviously

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is—in both; for the propagation of induction outwards being resisted with a force that increases *as the squares of the quantities* of electricity acting in that direction, will, with some certain proportion of the charge, be as powerfully resisted as induction inwards projected by some other certain proportion across the interval.

187. The induction, then, of the plus charge in the hemispheres considered as *action*, will have two separate *reactions* opposed to it, which in intensity will of course be equal to it, and therefore to one another. Now the proportion which the two parts of the charge, or quantities—one on the outer surfaces of the hemispheres and the other on their inner surfaces—will bear to one another while establishing this equality of intensity, will depend upon the length of the interval through which the electrical attraction is independently projected, the charge of the inner surface being greater as that distance is less, because the force of electrical attraction varies in some ratio of the distance that must be an inverse ratio.

188. We submit that the preceding experiment finds an intelligible causation when thus viewed, and that the way in which we are regarding it is fully justified by every consideration that can be brought to bear upon it. We consider that it fully proves the projection of electrical induction through space, and the importance of that conclusion is immense, as we shall find in the sequel.

189. Five different methods of conferring charging capacities upon conducting surfaces have been already shown, all dependent upon the instrumentality of the artificial electrical equilibrium, (par. 121, 126, 148); but now we have added to them a sixth method, and one that is independent of the reduction of intensity by the diffusion of induction, clearly implying the projection of induction across spaces of sensible magnitude, without any dependence on intervening matter, whereas the former have all handed it onward from particle to particle.

190. By varying the above experiment we can cause it to show in a more direct manner that the uninsulation of the inner ball actually confers charging capacity upon the inner surface of its conducting envelope.

Exp. 29. Place the two hemispheres (fig. 27) together, and insulate them, the wire being withdrawn from the glass tube of the upper one, so that the ball within shall have nothing conducting projecting from it into the external atmosphere. Connect the hemispheres by a wire with the ball of the gold leaf electrometer, and communicate to them a sufficient plus charge to make the leaves of the electrometer diverge; the angle of that divergence, being an indication of the intensity of the charge, may be used as a measure of the charging capacity of the whole conducting system; for by its increasing or diminishing, *the charge meanwhile remaining unaltered*, we shall know that the charging capacity of the system as a whole, has undergone a diminution or an augmentation, respectively. Now, while marking the extent of the divergence by the eye, pass a fine wire down to the bottom of the glass tube, thus uninsulating the brass ball situate within the hemispheres; the result will be that the divergence of the leaves of the electrometer will sensibly diminish, proving that the uninsulation of the ball has conferred a charging capacity on the inner surface of the spherical case around it which it had not before—which it would not acquire inductively by propagation, and should acquire by an independent projection of attraction across the sensible distance.

191. While we have this little apparatus under consideration, we may perform with it another experiment or two for confirming generally the deductions we have derived from our theory.

Exp. 30. The two hemispheres being put together, with the wire in the tube communicating with the inclosed ball, give the latter a charge of plus electricity, while a finger is placed upon the hemispheres to uninsulate them. We shall then have an internal plus charge and an external minus charge, which by our theory ought to be equal to one another; simply because, owing to the definite character of electrical attraction, a quantity of electricity equal to the plus charge, is virtually dismissed from each successive spherical shell of aërial particles around the ball, a similar quantity becoming actually dismissed finally by reason of the induction falling upon an uninsulated conductor. Now if the plus and minus charges be equal in quantity, they ought to be capable of exactly neutralizing one another; and this we shall find they will do, if, after drawing out the wire of communication by means of a varnished silk thread previously fastened to it, we lift off the upper hemisphere, and bring both it and the ball together into contact with the lower hemisphere, for, after such a contact there will be no electrical charge of either sort remaining to affect a gold leaf electrometer.

Exp. 31. Put the hemispheres together, and communicate to them a plus charge, while the ball in their centre is being uninsulated by means of a finger placed on its wire of communication. We have already seen that by this means we shall cause the plus electricity to induce a minus charge on the surface of the ball. The wire being then drawn away, separate the hemispheres and bring the upper one and the ball, both at the same time into contact with the lower hemisphere, as in the last experiment; there will now on examination be found on every part of the conducting system some plus electricity, showing an excess of the original plus charge over the minus one, and clearly proving that its induction was only partly directed towards the ball, and partly on the external atmosphere, the internal surface of the hemispheres deriving a charging capacity from the power of the electrical attraction to *project* itself, and their outer surface having a charging capacity established by the propagation of the attraction from particle to particle,and its diffusion ending in artificial equilibrium. Now, the plus charge on the *inner* surface of the hemispheres, being by the theory equal to the minus charge on the surface of the inclosed conductor, they would of course exactly neutralize each other, leaving the plus charge on the *outer* surface of the hemispheres to remain a plus charge still; and that exactly corresponds with the fact.

(*To be continued.*)

INDUCTIVE RESISTANCE.

We have reason to believe that the theory we are founding upon the definite electrical equivalents of common matter will repay the strictest investigation, if only the enquiry be made in that spirit of forbearance which every innovation upon habits of thought cannot fail to need; and we have invited communications from any of our readers to whom we failed to make its principles clear. We learn from correspondence received, that we have not made quite intelligible in our "Steps to Theory" the particular electrical state of things relating to inductive atmospheres, and we therefore take the first opportunity for further explanation.

We are asked to what distance from a charged surface does its inductive atmosphere extend? Let us see wherein we have been remiss in leaving such a question necessary.

In paragraph 67 we showed that in consequence of the definite attraction of electricity by common matter, and the electrical law of quantity, together with the geometrical properties of concentric spheres, that electrical induction, setting out from a point and falling upon individual particles of air, became *reduced in the intensity of its force as the fourth power of their relative distances.* We omitted to say for the benefit of those who might need such elementary instruction, that when a force diminishes in that or in any other ratio, it can never mathematically come to an end, as, however frequently it be divided, some part of it will always be left.

In paragraph 69 we said *it is impossible to contemplate this rapid reduction of electrical intensity by surrounding a plus charge by a sphere of aërial matter of adequate radius, without perceiving that it must at no very great distance from the centre, depending upon the magnitude of the original charge, die away into insigni-*

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ficance; giving existence to a state of things that we may understand to be a substitute for the natural electrical equilibrium. Here again we had an opportunity of saying, to those who might have required the information, that the intensity did not ever die away altogether. In paragraph 79 we have modified the expression to *dying away to insensibility at some distance;* and in paragraph 87 (misprinted 81) we substituted the words *so reduced in intensity as to be no longer appreciable.* But still on no occasion did it occur to us to say that a force that was perpetually diminishing could never come to an end.

We must therefore acknowledge that we have not done quite all that was possible to prevent its being imagined that in our estimation static electrical induction is a force "vanishing at a particular distance," as our esteemed correspondent has reminded us.

But we hope there will be no further misconception about it; we now say in plain terms that static electrical induction, acting from a point on boundless fields of air, is limited to no boundary; but that, nevertheless, it speedily becomes too minute in its intensity to affect our instruments and organs of sense, even at comparatively short distances. And if we would form estimates of relative inductions, we must observe their intensities either at the places where their existence may just be perceptible by means of our most delicate apparatus, or at some shorter distance from the respective charges where the intensities may be great enough to be measured and found equal.

Another interrogatory put to us, is, "at what distance off from a conductor, may the surrounding objects be?" The answer to this question has been so abundantly given in all that we have been saying in the "Steps" for the last two months, that in the absence of our correspondent's assurance to the contrary, we can only imagine that he has been too much occupied to look into it; it could not be concisely reproduced, and under such circumstances, not to tire the patience of our other readers, we can only beg of him to turn back to it. Had he tried without success to comprehend our meaning we should have taken the fault to ourselves, and have hastened to supply its correction; we had in view this estimate of our responsibility when we penned our 120th paragraph. The subject, however, is being continued.

MESSRS. HALL AND WELLS' DEEP SEA CABLE.

AT the present moment, when the subject of deep sea telegraphy occupies the public mind to so great an extent, a description of a few of the cables submitted for test under the direction of the late Experimental Committee of the Board of Trade, cannot fail to interest all those of our readers who are interested in the success of ocean telegraphy. We this week place before our readers a description of one of such cables, designed and patented by Messrs. Hall and Wells, of the Telegraph Works, Borough Road, Southwark. This cable consists of a copper conductor, insulated in india rubber, sheathed in a longitudinal strand of hemp, steeped in pitch and cork dust; and 8 longitudinal steel wires, braided together with 14 strands of hemp, saturated with the best Stockholm tar.

The advantages of a cable strengthened with steel or iron wires, having a longitudinal direction, and imbedded in a plaiting of hemp and cork dust, steeped in Stockholm tar, consist of great strength, light specific gravity, non-liability to kink, and a protection to the wires against oxidation.

We had recently an opportunity of examining a portion of a cable constructed upon the above principles, which had been subjected to the action of water for a period of nearly three years, and we found that the steel wires and the hemp were in a perfect state of preservation. The subjoined table affords some practical information as to the applicability of such a cable for deep sea purposes (see Government Report, page 389).

We admit that a considerable difference of opinion exists among our telegraph engineers as to the best description of cable for deep sea purposes, but among seafaring men, who have been engaged in the submersion of cables, the opinion prevails that the lighter the cable, with an equivalent amount of strength, the better. Another objection is urged that a cable covered with hemp is liable to be destroyed by submarine insects, such as the toredo. The same objection may be raised against iron sheathed cables, inasmuch that in several instances the iron has been found to have been completely eaten away by rust, leaving the core compeltely at the mercy of the marine devastators.

Number of Specimen.	Weight. Put on.	Weight. Total	Length of Sample between Clamps.	Elongation.	REMARKS.	
	lb	lb	feet			
1	2240 672	2240	20	0	Specific gravity of Cable as compared with Sea-Water, 1·4	8 Steel Wires
	2912 448	2912		1/16		Guage { Birmingham No.14 Decimals of in. — ·0789
	3360 448	3360		2/16	Weight in Air, per mile, 0·8205 ton	
	3808 672	3808		3/16	Weight in Sea-Water, per mile, 0·2344 ton	Diameter of Cable 0·875 in.
	4480 2240	4480	.....	1/2	Weight removed	WIRE AND RUSSIAN HEMP COMBINED.
	2240 2240	2240	.....	3/16	Set of Cable	Weight per Fathom 2·088 lb.
	4480 448	4480		1/2	Length in Fathoms that would break with its own weight when suspended in Sea-Water, is 10,810	20 Longitudinal Strand of Hemp steeped in Pitch and Cork Dust, and 8 Steel Wires, Braided together with 14 Strands of Hemp, saturated with best Stockholm Tar
	4928 448	4928		11/16		
	5376 448	5376		7/8		
	5824 448	5824		1 1/16		India Rubber Insulation
	6272 168	6272		1 7/16		
	6440	6440			{ Broke = 2·875 ton tensile strength }	
2	1958 672	1958	20	0	Specific gravity of Cable as compared with Sea-Water, 1·35	8 Steel Wires
	2630 504	2630		1/4		Gauge { Birmingham No.15 Decimals of in. —·0689
	3134 504	3134		7/16	Weight in Air per mile, 0·723 ton	
	3638 168	3638		13/16	Weight in Sea-Water, per mile, 0·1874 ton	Diameter of Cable 0·75 in.
	3806 504	3806	.....	.....	*The measuring-rod here slipped from its fastening thereby giving the elongation incorrect	WIRE AND RUSSIAN HEMP COMBINED.
	4310 504					Wight per Fathom 1·84 lb.
	4814 336				Length in Fathoms that would break with its own weight when suspended in Sea-Water is 11,635	20 Longitudinal Strand of Hemp steeped in Pitch and Cork Dust, and 8 Steel Wires, Braided together with 24 Strands of Hemp, saturated with best Stockholm Tar
	5150 168					
	5318 168					
	5486	5486			{ Broke 2·45 ton tensile strength }	India Rubber Insulation

In a future number we shall give an illustration of the cable.

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PRICES CURRENT OF INSULATING MATERIALS.

GUTTA PERCHA.

None in the market.

INDIA RUBBER.

Fine Para ...	... ...	2s. 2d. per lb.
Negro Head	... ...	1s. 1d. to 1s. 3d. per lb.
Java ...	... ...	1s. 5d. to 1s. 6d. „

April 30, 1862.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
50	British and Irish Magnetic, A.	all	29 to 32	———
20	Do. B 7 per cent. till 1862 .	all	18 to 20	———
20	Do. C. „ „	all	9 to 11	———
10	Channel Islands Telegrap .	all	———	———
Stock	Electric Telegraph . .	100	98 to 101	———
25	Do. New . . .	15	— dis.	———
5	London District Telegraph .	4½	3¾ to 3¼ dis.	———
10	Mediterranean Extension Tel.	all	3½ to 4½	———
10	Do. 8 per cent. pref. . .	all	———	———
20	Red Sea and India Telegraph	all	19 to 19¼	———
1	Submarine Telegraph, scrip.	all	3/8 to 5/8	———
1	Do. registered . . .	all	3/8 to 5/8	———
10	Do. „ . . .	all	4 to 6	———
2	Telegraph to India . .	1	⅛ dis. ¼ pm.	———
5	United Kingdom Telegraph .	2¾	1¼ to 0¼ dis.	———

Colonial and Foreign Telegraphy.

TELEGRAPH TO KING GEORGE'S SOUND.

THE *Melbourne Examiner* contains a long and interesting letter advocating an extension of the Australian telegraph system to King George's Sound. The readers of Mr. Todd's annual reports will be aware that this is no new idea. That gentleman long since expressed his opinion that the colonies should look forward to a line round the Continent, so as to touch at Western Australia, and at any new settlements that might be formed on the coast, in perference to a line across the uninhabited interior. The great advantage which he has pointed out from the adoption of this course is, that the colonies would be at once, on the completion of the line to King George's Sound, brought several days nearer to England, as the mail could be anticipated on its arrival, and supplemented on its departure.

The letter which we now refer to dwells largely on this point, and enters into particulars as to the cost of the line, and the best mode of paying for it. The writer states, that a proposition "to take the debentures of the several colonies, at their market value, in payment of the plant for telegraphic communication to the Sound, is at this moment under the consideration of one of the most responsible mercanticle and electro-telegraph manufacturers in England, and it is by no means impossible that the next mail will convey authority to an agent qualified by them to make the offer to the united Australian Colonies." With regard to the question of cost, the writer of the letter quotes a "competent authority" for estimating the probable outlay, on account of construction, at £180,000. But this is nearly three times as much as Mr. Todd's estimate. The great discrepancy between the two arises, we find, from the Melbourne correspondent putting down £150 per mile as the cost of making the line, whilst Mr. Todd proposes £50 per mile, as a sufficient expenditure. The cause of this great difference appears to be, that whilst the writer of the letter seems to think it necessary that the line should be carried round the Australian Bight, in the track of Eyre's expedition, Mr. Todd is of opinion that an easily passable and moderately good country might be found further inland—a supposition which is largely confirmed by recent discoveries. There is nothing, in fact, to warrant the conclusion, so readily adopted by some persons, that there is nothing but bad country between Stuart's north-west tracks and the settled districts of Western Australia. On this side, explorations made inland have certainly shown the country to be of a promising character, and on the other side a recent expedition from Northam, in Western Australia, penetrated several hundred miles into the unknown interior without finding any obstacle in the character of the territory passed through.

But, great as the difference of opinion is as to cost of construction, it is greater still on the subject of maintaining the line. This expenditure the Melbourne writer puts down at £8,000 per annum, whilst Mr. Todd's estimate is £2,500 or £3,000 per annum. This small sum was proposed, because Mr. Todd was of opinion that stations along the line might be maintained at small cost, if there were attached to them the right of pasturage such as to induce squatters to settle upon them. He says:—"By the adoption of this plan I think intelligent persons of limited means would be found willing to undertake the duties at a comparatively small amount of remuneration; and it should be remembered that a land line would greatly facilitate the settlement of remote districts." In reference to these suggestions, it must be borne in mind that they were first put forward in objection to Mr. Gisborne's scheme, and at a time when Mr. Stuart had not returned from his first expedition to the north. But Mr. Todd has even recently expressed himself in favour of a line to Western Australia, when the time for undertaking such a work arrives.

At present this question may be considered to be in abeyance. Mr. Gisborne's scheme for a submarine line has completely fallen through, and we imagine that the question of a land line intended to terminate on the opposite coast is not likely to be decided upon by the several colonies, until Mr. Stuart has shown whether his route can be made available. A line to King George's Sound would be, undoubtedly, an advantage to all the Australian colonies, and any scheme submitted to the several Governments would, no doubt, be fully considered. But we are afraid that estimates on the scale of £180,000 for the making of the line, and £8,000 per annum for maintaining it, would intimidate the local Parliaments. Preliminary, however, to anything that could be effected for the purpose of extending our telegraph to King George's Sound, some exploration would have to be undertaken for the purpose of ascertaining the character of the country to the west of Fowler's Bay. Nothing has been done yet towards examining, from an inland point, the three degrees of territory lately added to South Australia by the Home Government. It is possible that suitable timber for telegraph poles, and an easily accessible track for the erection of a line might be found in this direction, and these are matters that would greatly affect the question of telegraph extension to King George's Sound.—*South Australian Register.*

ANGLO-AUSTRALIAN TELEGRAPH.

WE find, from recent Singapore papers, that great hopes are entertained that Mr. Stuart's successful explorations will lead to the telegraphic connection of Australia with India, and, through India, with England. The difficulties which have been experienced with the Red Sea telegraph have retarded the progress of one part of the Anglo-Indian line, but those difficulties are in the way of being overcome. For a long time the greatest trouble was experienced with the submarine telegraph on the Mediterranean side of the Isthmus of Suez; but our last files of English papers inform us that an excellent line is now in operation between Malta and Alexandria, and the successful extension of this to Aden is only a work of time. Meanwhile, we find lines are being carried, with more or less success, through India in the direction of the Australian Continent; and thus the way is being prepared for the great extension which must some day bring the wires from the Straits settlements to these colonies. The *Singapore Free Press*, after congratulating its readers on the great achievement by which Mr. Stuart had brought Adelaide, Melbourne, and Sydney so much nearer to India, says:—"The substitution of a line across Australia would leave only a very small extent of sea to be crossed before it would reach the Netherlands India possessions. From Melville Island on the coast of Australia to the Island of Timor is not much more than two hundred miles, and from Timor the line can be carried to Java almost entirely by land, the only interruption being the five or six narrow straits separating the chain of islands which lie between the two points." Between Java and Singapore we learn the first attempt to lay a submarine cable has proved a failure, owing to the rocky and coraline nature of the ocean bed which it had to cross. But the attempt is about to be renewed, and the line, it is thought, will now be made less a submarine work than before, by being carried along the shores of Sumatra. This will leave us the only submarine cable of any length on this side of Bombay—the line which is to connect Rangoon with Singapore—and that, it is said, might just as easily have been carried all the way by land. The journal we have quoted from says:—"It is a pity that, with the means of carrying the line from Rangoon to Singapore by land, the Government did not pause before incurring the expense of a costly submarine cable, which all the experience hitherto gained regarding such cables shows will most likely turn out to be very defective, and productive of frequent and most annoying interruptions. These interruptions, indeed, will probably be found so intolerable when we are connected with Australia, that at no distant period it will be absolutely necessary to establish the land line, and the expense incurred for the submarine cable will then be so much money thrown away." In reference to these remarks, it should be borne in mind that when the Rangoon line was commenced, much of our experience as to the troublesome nature of submarine cables had not been obtained, as most of the failures of this kind of telegraph lines have taken place since.

Supposing the Red Sea line to be effectually laid down, and connected with the Indian lines, extending so far towards this continent as the island of Java, the question of an overland Australian line will of necessity force itself upon the attention of the Colonial Governments. One of the reasons, we believe, why Mr. Gisborne's scheme for taking a cable round the continent has been allowed to fall through so quietly, is that Mr. Stuart's explorations have shown an overland route to be practicable. This, too, probably influenced the Home Government in its view of Mr. Gisborne's scheme, when communicated with on the subject by the

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Government of New South Wales. The answer of the Duke of Newcastle, as published in the Sydney papers, was as follows :—

"SIR,—With reference to previous correspondence on the subject of the establishment of telegraphic communication between Europe and Australia, and more especially with regard to Mr. F. Gisborne's recent mission to Australia as agent for the promoters of a scheme *viâ* Java and Moreton Bay, I have the honour to inform you that the Lords Commissioners of the Treasury have intimated to me their inability to co-operate with the Governments of Australia to establish the proposed communication. Their Lordships further stated that, as the chance of such an undertaking being successfully carried out was at present so uncertain, they should not feel themselves justified in applying to Parliament to add to the various liabilities which Her Majesty's Government have already incurred in respect of lines of telegraph which, it was supposed, could easily be established, but which have as yet resulted only in failures, owing to the unforeseen difficulties which attended the maintenance and laying of submarine cables.—I have, &c., NEWCASTLE."

The question of an Anglo-Australian line would here appear to be postponed indefinitely, on account of the unforeseen difficulties which had been found to attend "the maintenance and laying of submarine cables" —difficulties which the Home Government doubtless believed would be more than ever felt in an attempt to carry out the scheme of Mr. Gisborne. But the interior of Australia has been crossed since that scheme was started, and the prospects of telegraphic communication with India are thus altogether changed. Much, however, has yet to be done before there is an unbroken line between Java and Alexandria; and the colonies need not yet anticipate the cost and labour which will attend the forming of a line from the one side of the Australian continent to the other. Still the undertaking is one which will have to be accomplished before many years are past, and which, when in successful operation, will, no doubt, be as advantageous to both India and Australia as our Singapore contemporary anticipates.—*South Australian Register.*

TELEGRAPHIC COMMUNICATION IN AUSTRALIA.—Active steps are being taken by the government of Sydney towards carrying out the works for telegraphic extension recently sanctioned by the parliament of that colony. The most important line will be the extension from Orange to Wagga Wagga, a length of 250 miles, connecting Sydney with the Burrangong and the Lachlan diggings. At Wagga Wagga the communication will be united with the South Australian system, so that there will be two independent lines between Sydney and Melbourne, there being already a communication between the latter city and Wagga Wagga, by way of Deniliquin, Echuca, and Sandhurst. The advantage of this extension will be that, in the event of the current being interrupted in the southern wires, the western line will be available for the transmission of messages between Victoria and New South Wales. Various other wires are being laid down in the latter colony, the authorities and the public being evidently impressed with the importance of telegraphic communication.

Telegraphic News.

BONELLI'S telegraph line from Manchester to Liverpool is now progressing. Ten wires are to be insulated with ebonite, and four with porcelain.

THE RED SEA TELEGRAPH.

MR. LATIMER CLARK left Aden on the 2nd inst. in the *Sir James Duke*, and is now engaged upon the section of cable between Aden and Kurrachee. The work will probably continue until about the middle of May, when, if not finished, it will be interrupted by the monsoons. In this case Mr. Clark will probably return to England for a period.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—Mr. Webb has found leisure to honour me by a long letter addressed to you in reply to mine; I wish he had devoted the time to making himself acquainted with induction and its resistance as they proceed from the fundamental causation in your "Steps to Theory," he would then have had personal experience of the truth describing the comprehensiveness of true theory that you, by a singular coincidence, gave utterance to simultaneously with the appearance of his epistle, and perhaps have been half inclined to suspect he had formed too low an estimate of yours, seeing, as he must then have done, that it embraced all his facts, and absorbed all his sound inferences, pointing out others as unsound. I have compared the two theories, and I again recommend Mr. Webb to do the same, for it appears to me that induction and its resistance, which he is endeavouring to relate to one another without reference to a causation for either, have been "on the common principles of mechanical philosophy" traced by you from electrical attraction as two of its most immediate consequences, and their relation thus reduced to numerical certainty. I do not despair of seeing your correspondent thus occupied some day, and I believe it would result, not only in a change of his views, but indirectly in the general good, for it is by such men that electrical science must be helped forward.

When, in the 21st number of the ELECTRICIAN, I said, alluding to Mr. Webb's able manner of treating his subject, "that every one would regret to find his doctrines had not a true basis to start from," I sincerely included myself in the number; and, though I have a preference for other theoretical views, he will only have to prove that though they be "supported by direct experiment" they *disagree* "with general results," and he will never hear another word from me in their favour. The only theory that can permanently retain my regard is, *the true induction of causation obtained from, and justified by, all electrical facts in common;* and the liberty which I think ought to be allowed to every one in his search after it may be gathered from my first letter to the Editor of this Journal, published on the 13th December.

In deference to Mr. Webb's desire to postpone discussion, I would, if it were possible, refrain from saying anything calculated to provoke a reply; but he will not expect me to remain silent when he asserts that his "calculations are in strict accordance with facts;" in contradiction to my denial of such an accordance. I will only refer to his experiments with the revolving machine and Leyden jars so far as is necessary to explain why I can have no confidence in their results; in the first place, one must make selection from a considerable number of Leyden jars, before he could find "three equal and similar," I have two that *appear* to be so, but I find when I use them that one will take a measured quantity of charge more than fifty per cent. greater than the other. He had, moreover, to do with "defective insulation;" so that his own confidence in his arrangements could not have been great, and he seems to admit that it was small, by his argument beginning with "the experiment could be much more accurately tried with a battery and three equal and similar lengths of submarine cable, than a frictional machine, which is, after all, a compound machine." Every one experienced in electrical experiments knows how prone any deficiency of accuracy is to vitiate the result. I have thought that Mr. Webb's purpose might be answered in a very ready and unexceptionable manner, by the employment of a De Luc's column; he will doubtless think that instrument "forms a much nearer approximation to a simple constant source than a frictional machine,' and he will know that it gives at, say, its positive pole, a charge that becomes ultimately of precisely the same intensity, whether it be used to charge an electrometer, an insulated sphere, a Leyden jar, or a coated pane of glass, the only precautions necessary being to have all the insulations trustworthy. Now, I will tell Mr. Webb how I have tested his theory by means of such a column, and of a set of coated panes of glass, each four inches square, with a disc of tinfoil, an inch in diameter, fixed in its centre on either side.

I believe I am quite right in stating that Mr. Webb's fundamental doctrine is this: the resistance opposed to electrical induction from either pole of a source is doubled when the action has to pass through two equal dielectrics instead of one; and that in consequence of that doubled resistance the resulting induction is only half as great. He must believe then, when I put two coated panes cut from the same sheet of glass upon the cap of a gold-leaf electrometer, and either pole of a De Luc's column upon the uppermost coating, its other pole being uninsulated, that I ought to have but half so great a charge induced as I have when I put only one of the panes; but instead of that—his theoretical result—this is what I find in practice:—whether I interpose between the electrometer and the inducing charge one, two, three, four, five, or six of these glasses representing Mr. Webb's resistances, I get scarcely, if at all, any appreciable difference in the angle of divergence caused in the gold leaves: and that result can prove no less than the fact that electrical induction permeates a larger number of the glasses as effectually as it does a lesser number. It is as well too that I should make known the fact that the coatings on the glasses cannot prejudice Mr. Webb's doctrine in any way, for the simple reason that they are unnecessary, for the result takes place just the same, only somewhat less promptly, when they are removed. I will append another fact, not less inexplicable, on the theory in question, though, as I could show if necessary, quite intelligible on yours; if the six thicknesses be combined in a single sheet of glass, the induction sent through the resistance by the pole of the column is scarcely sensible by the electrometer.

I will not at present add to these facts, they put Mr. Webb's case very fairly, and it cannot stand before them; I shall, therefore, turn abruptly to a somewhat preposterous imputation which that gentleman has compelled me to rid myself of; he has represented me as "holding that unequal generation from the two poles of a source can occur." In so doing he has evidently overlooked an alternative in doctrine that he might with equal reason, and more grace, have imputed to me; when he asserted "if the charge on the plate A is diminished whilst the charge of D remains the same, unequal quantities must be generated at the two sides of a source," he could hardly have refrained from perceiving—the charges of A and D being originally equal—that the separation of B from A would necessarily throw back part of A's charge, on to the conducting communication between it and the source. *What effect the removal of that communi-*

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cation would have, I, in those very words, left Mr. Webb to say; am I to suppose he still remains unconscious of its having been present?

If Mr. Webb requires my confession of faith, here it is: I believe that matter generally can be temporarily deprived of some of its native electricity, and that that which any portion loses some other portion must gain; so that the plus and minus conditions must needs be contemporaneous and equal; and thus falls all the imaginative reasoning that your correspondent has built up upon my presumed electrical heterodoxy; he has branched out from it into many conclusions into which I am glad to have no occasion to follow him.

I should like to get some good out of this discussion, for I may be, as he expresses it, "one of those who have studied electricity principally from experiments on frictional machines in a room, and unacquainted with the mine of facts connected with accumulation which have been opened out by submarine telegraphy." I shall, therefore, make him a proposition; if Mr. Webb will work out by his view of inductive resistances the quantities and intensities of charges for half-a-dozen experiments that shall be suggested to him, and in simple language show them to be in harmony with what will practically occur when the experiments are tried, I will submit the view of induction and the resistance opposed to it, in which I have confidence, to a similar ordeal, and to as great an extent as he may choose to dictate; and he shall have the privilege of selection from among the cases which he has enumerated as those with which he thinks me least familiar, namely, "cases of accumulation when both poles of the source are insulated, and the surfaces of the conductors attached to each pole greatly disproportioned, the facts relating to the charging and discharging of submarine cables, also the case when a single conductor is charged in the usual manner of approaching the surrounding objects to it;" or even "experiments on inductive circuits composed of two successive resistances," provided only that he make me know all the *conducting communications* and other conditions implicated, even though they might be thought unessential to his calculations. Au Revoir.

April 26th, 1862.

To the Editor of The Electrician.

Sir,—Amongst the various forms of battery described in your valuable journal, you seem to be in favour of Daniell's. First, as the most powerful and expensive, stands that of Grove; expensive in the first instance by the cost of the platinum; next stands that of Bunsen, a powerful arrangement, and much cheaper than Grove's, but then with these two forms comes the expense of the nitric acid, which becomes decomposed, weakening the battery long before the strength of the acid is completely gone. Taking into consideration the expense of platinum, carbon poles, and nitric acid, I think that these two sources of electricity are very expensive, though very powerful, but of short duration compared with that of Daniell's, which no doubt would do more work, taking a longer time to do it. Now suppose with a Bunsen or Grove's form of battery, of a given size, what size or number of elements must I use to bring a Daniell's up to that power; is there any calculation to assist me in this matter, as I think that Daniell's would be cheaper and far more preferable. Then again there are various forms of cast-iron batteries, Callans, Sturgeons, and Maynooth, all powerful sources of electricity; the greatest objection to these being that when the cast-iron is used for the negative in nitric acid, that after a short time, when the strength of the nitric acid becomes somewhat diminished, the cast-iron becomes rapidly acted upon, evolving dense fumes of nitrous oxide, the nitric acid working over the porous cell on to the zinc element, and completely putting an end to all further experiment for the time. Why all such batteries are enumerated I cannot possibly make out, unless it be to teach amateurs which is really the best in the end. All these various batteries an experimentalist is tempted to try because the inconveniences are not pointed out at first. I could mention many others having all these drawbacks; following these come those that are constructed on Smee's principle, which I think must be allowed are very excellent in their simple and easy management, and if we could obtain something cheaper than platinized silver, they certainly would, I think, equal Daniell's in their arrangements, only one fluid being used. I recollect reading somewhere that if boron be put on copper in the place of platinized silver or lead, it would act the same; is this correct? If such is the case why is it not used, for it certainly would be more economical. I find that in many treatises on galvanism that many different forms of batteries are mentioned, but it would be impossible for an amateur to experiment with all. The difficulty that arises with the student is that amongst all these various arrangements he does not know which to choose from; of course I am not speaking as to telegraphy, but merely as to batteries used for experiment by amateurs. The cast-iron battery referred to in one of your late numbers must certainly be expensive, for in that arrangement there are two metals being consumed by the action of the acid solution; no doubt it gives a great quantity of electricity, but I should think not more than a Daniell's with the same surface of metals exposed. In speaking of Daniell's I must say that I have never used one, but have been led into this argument from your praise of it. I have hitherto confined myself to the more powerful sources, such as Bunsen's. I have noticed that in this arrangement the battery is more steady, and continues longer to remain in action after the sulphuric acid solution has become saturated with sulphate of zinc. Reasoning from this, that if the zinc element be charged with a saturated solution of sulphate of zinc, and the carbon charged with peroxide of lead, I should obtain a good and constant battery quite as cheap, and I should imagine, more powerful, both in quantity and intensity, than Daniell's; the carbon plates in this arrangement are the most expensive, but why a piece of coke should cost so much for cutting certainly puzzles me; zinc, acid, and porous jars are cheap enough. I should recommend amateurs to obtain a piece of wood rather smaller than the porous jar, and coat it well with hot resin, and while hot rolled well in powdered coke, they will then have a carbon pole equal to a solid piece of carbon. As another cheap source of electricity for quantity in a short circuit for experiment, I should recommend sheet-iron for the positive metal, as suggested by me in a former letter.

After reviewing the various forms of battery that an amateur is most likely to use, it may be well, perhaps, to give a list of those which I think may be preferred, leaving out that of "Groves." I should recommend as easy of construction that of Bunsen's, a very powerful source, both in quantity and intensity; next to this (being of the same form) for a cheaper mode of constructing the negative element, a cylinder of *good cast-iron*. This I think will be found quite as powerful as graphite, the only objection to its use I have previously pointed out; and lastly, that of Smee's and Daniell's, the latter, according to your own showing, is all that could be desired. Trusting I have not trespassed on your valuable space too much, I remain, yours respectfully, J. Cook.

[The quantity of electricity furnished in short circuit with the cast-iron battery is immensely greater than that, with equal surfaces exposed, of the Daniell arrangement. We have pointed out that *ultimate* economy is generally of little importance to the student and amateur; but experience has fully shown that where continued action and ultimate economy are regarded the Daniell battery has *hitherto* proved to be the best.—Ed. E.]

Miscellanea.

Royal Engineers.—On Tuesday another of the series of lectures for the present session, was delivered by Captain H. Schaw, R. E., in the lecture theatre of the Royal Engineer establishment at Chatham. The whole of the officers and men under instruction attended the lecture. The subject of electricity having been treated on in a previous lecture, its application to telegraphy was in this instance fully and clearly described, the method of producing the currents, and the different batteries in use being shown by experiments. In the school of telegraphy at this establishment the men of the corps selected for instruction are taught to use the single and double needles, magnetic and printing, also the laying down of wires, connecting batteries, and the making of the instruments. Every man, previous to his being returned as a telegraphist, must be able to read the maximum number of words in a minute.

Deep-Sea Telegraphs.—The history of submarine telegraphy—fairly written—would reflect little credit, either scientifically or morally, upon the present age. In truth, the business of making and laying telegraphic cables is—after a lapse of ten years since their introduction—only now commencing to be treated with the dignity of a science. Great and useful principles have been elicited by repeated failure, but they have been mostly ignored in practice. Experience there has been, but its lessons have too often been disregarded and thrust aside. Discussion there has been in abundance, but its tone has been too much for the display of theoretical learning to contribute to any valuable result, and far more apologetic in behalf of error than solicitous for truth—the grain of scientific wheat being usually hidden in a measure of algebraical chaff and mystification, as if to create and keep up a sort of telegraphical hierarchy, unapproachable except by the initiated. This latter mode of treating the question is especially the most dangerous and unnecessary that could be adopted, except for the purpose of speculative philosophy; as the successful construction of the telegraph is no mystery to any mind of fair capacity; depending, as it does, simply upon the practical application of a very few easy and perfectly well-known natural laws.—*Deep-Sea Telegraphs: their Past History and Future Progress.*

To Correspondents.

J. C.—We cannot imagine that the wires can be "over insulated." Have you tried the effect of reducing the condenser. We should consider it an advantage to have a succession of currents in one direction only, as appears, if we understand you rightly, to be the case.

ERRATA.

Page 259, 2nd col., 27th line, the existing fluid used is one part of concentrated sulphuric acid to 3½ parts of *a saturated solution of salt*.

Page 300, line 24, "*but it is*" should be "*but if it is*," &c. Line 40, "*an*" should be "*any*."

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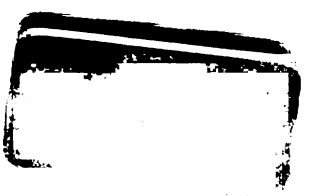

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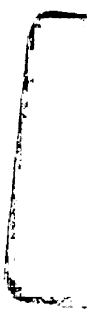

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